Aalto University
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"YES IT CAN": STATE SUPPORT FOR RENEWABLE ENERGY INNOVATIONS IN FINLAND

Assessing the need for an "entrepreneurial state"

Master's Thesis
Ekaterina Perfilyeva
Aalto University School of Business
Department of Management Studies
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Aalto University
School of Business

Aalto University, P.O. BOX 11000, 00076 AALTO
www.aalto.fi

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Author Ekaterina Perfilyeva

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Abstract

This qualitative interview study focuses on the role of the state in supporting the development of renewable energy innovations in Finland. The study aims to answer the question of how the government can support such innovations from the private sector's point of view. The main objective of the thesis is to develop a set of recommendations for Finnish policymakers on improving energy and innovation activities, policies and support tools to help businesses develop new renewable energy technologies. The study also aims to make an empirical contribution to Mariana Mazzucato's recent concept of the "entrepreneurial state" by applying it to the energy sector in the Finnish context.

The main subjects of the study are innovation and energy policies and the role of the state in innovation. The thesis is based on alternative evolutionary economics concepts on innovation development. The empirical part of the study was based on qualitative semi-structured interviews. Several Finnish companies engaged in the development of innovations in the field of solar, wind, geothermal energy and biofuels were interviewed to identify the private sector's needs for public support for innovation. Additional interviews were conducted with organisations directly related to the Finnish energy market and innovation policymaking to collect sector-specific information on Finnish innovation environment.

The interviews generated findings on a multitude of challenges and concerns of the private sector related to the development of new renewable energy technologies and products in Finland: absence of sufficient private venture capital, rigidity of the Finnish energy market, investment unattractiveness of renewable energy due to low energy prices and politicisation of energy issues. The interviewees have also produced critique of the current renewable energy policies and tools and pointed out at Finland's potential in utilising its expertise in various energy technologies to develop valuable export goods.

Based on the interviews, a list of recommendations for policymakers was developed and compared to the conceptualisations of the "entrepreneurial state". Overall, the findings point at the need for a government that is actively involved in supporting renewable energy development with policies, regulations and tools. However, the leading role should be played by markets. The state needs to be ambitious and creative in setting targets, think long-term and stick to its strategies. It needs to depoliticise energy issues and be technology neutral in renewable energy policies, support pilot projects and utilise Finnish natural context and energy know-how. The study has shown that in Finland the government has already been quite instrumental in helping the development of renewables so there is not a big need to apply the "entrepreneurial state" rhetoric. However, in practice it is still important to unpack and reconsider the role of the state in supporting innovations, especially within the energy transition imperative where states may play an increasingly important role.

Keywords innovation, innovation policy, renewable energy, energy policy, entrepreneurial state

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1 INTRODUCTION

This thesis explores the role of the state in supporting the development of renewable energy innovations in Finland and provides the recommendations for policymakers on improving renewable energy support activities.

In this chapter I introduce the motivations for the study with insights into climate change, energy transition and renewable energy. I connect that discussion with the topic of innovation and Mariana Mazzucato's concept of the "entrepreneurial state" which was the main stimulating literature behind the research. In the end the research idea, research question and objectives are outlined.

Chapter 2 provides the literature review for the study. It starts with an orthodox perspective on the role of the state in the economy and continues with alternative concepts to offer a theoretical ground through which the novel "entrepreneurial state" discussion can be better understood. The second part of the literature review gives a more detailed overview of the "entrepreneurial state" and its main themes. I then present the critique of the concept, summarise the literature review and explain the role of theory in this study.

In Chapter 3 all methodological foundations of the study are explained, including research process and qualitative interviewing methodology. The data collection section provides a more detailed description on the interviews conducted for the research. The data analysis process is then outlined as well as research limitations and ethical considerations.

Chapter 4 introduces the empirical context for the findings. There I describe the state of the renewable energy market in Finland and outline the government's support tools for renewables. In the end I also give some insight into the key organisations related to innovation policymaking in Finland that are frequently mentioned in the discussion part.

Chapters 5 and 6 contain findings and discussion. Chapter 5 focuses on the main themes found in the interviews as the outcome of thematic analysis. It first provides brief profiles of the interviewees to give an idea of their relevance to the development of renewable energy innovations. It then provides a full overview of the interview themes based mainly on the interviewees' critique of renewable energy support tools, Finnish innovation system and energy market. To make the outcomes of the research clearer, Chapter 6 deals specifically with recommendations for the improvement of state support for renewable

energy. The chapter includes the discussion of recommendations by themes, their summary as well as thoughts on how the outcome of the research may be related to the "entrepreneurial state" conceptualisations.

Finally, Chapter 7 summarises the main themes and recommendations generated by the study, its limitations, practical implications and provides suggestions for further research.

1.1 We need renewable energy

The past decades can be characterised by what can generally be defined as a global environmental crisis, referring to a multitude of alterations in the natural processes that present humanity with environmental, economic and social challenges. One of the biggest issues of this crisis is climate change, which is often described as a key challenge of the 21st century. Climate change is caused by the excessive amount of greenhouse gas emissions in the atmosphere that disrupt natural cycles and threaten the well-being of the planet's ecosystems.

It is by now evident and scientifically proven that economic activity of humans is to blame for climate change (IPCC 2007). Decades of rapid economic growth based on increasing production and a growing population led to an increase in the use of conventional energy based on coal and oil, the burning of which is the greatest source of emissions. Greenhouse gases, which are high in carbon content, stay in the atmosphere and block the energy that would otherwise be reflected from the Earth's surface causing surface temperatures to rise - this is more commonly referred to as global warming. Unusually warm earth and ocean temperatures trigger unforeseen feedback loops in the natural cycles causing their disruptions with negative consequences for the planet and its living environment, including humans. The global community has become increasingly alert, and in the end of 2015 adopted the Paris Agreement, an international treaty with the goal to keep global warming within the 1.5°C-2°C threshold by cutting greenhouse gas emissions (UNFCCC 2017). The agreement was signed by 197 states and triggered a truly global momentum making it clear that reducing greenhouse gas emissions is now firmly on the world's agenda.

Globally, 25% of emissions come from electricity and heat production, 21% from industry and 10% from other energy-related activities (US Environmental Protection Agency 2017), making the energy sector a major contributor to the problem. The need to transition to low-

or no-emission "clean" energy sources (also referred to as the process of "decarbonisation") has been realised by the international community, that during the last fifteen years has been promoting a rapid increase in the development and deployment of renewables that utilise natural phenomena like sunlight, wind, geothermal heat or tides to produce energy.

Despite the fast development of the renewable energy market, the deployment of renewables is still on a level not sufficient to significantly reduce emissions related to the use of conventional energy. While there is a need to increase the share of renewable energy in the overall energy mix, there is also a need to satisfy the growing global demand for energy for the growing population, meaning that energy efficiency is yet another challenge which is partly why conventional (and often cheaper) energy is still being invested in. These issues have been raised by researchers and policymakers in many states, notably in Europe, where currently a big discussion on energy transition continues, as the energy market alone does not seem to be able to fix the problem in the speed needed to halt climate change before its negative consequences become irreversible. It has also been evident on a global scale that governments play an increasingly important role in developing and implementing top-down policies and support schemes to help the private sector transition to renewable sources.

The state can play a key role in the energy transition yet there are multiple challenges policymakers may face within this huge imperative to transform energy systems. Decades of oil-dependence have tied energy issues not only to the economy and the environment but also international security leaving many states with the dilemma of competing economic, environmental and security objectives (Holdren 2016:18). Holdren (ibid.) states, that there is a need, therefore, for policies which help find compromise among those competing objectives and accelerate the development of energy technology innovations, so that over time there can be more energy options that will reduce tensions. Rodrik (2014:470) explains that investment decisions could be left to businesses and financial markets if markets worked well, i.e. natural resources would be priced with consideration of full social marginal costs, and technological benefits would be internalised by actors in charge of research and development (R&D). Since energy relates to public goods like security and by far the negative externalities of the energy sector like air pollution or greenhouse gas emissions are not priced, the states need to get involved and supplement the economy with policies to solve problems that markets cannot otherwise solve.

The European Commission admits that there is a need to introduce national support systems and spur increased investment in renewables as markets alone cannot deliver the desired level of renewables in the EU (EC 2017d). It also admits that support policies have to be designed carefully in order not to distort the functioning of the energy market which could lead to higher costs for European households and businesses (ibid.). The question of costs in the overall energy transition is however inevitable – in Holdren's mind, one of the biggest challenges in the energy transition is the large amount of embodied capital investment and long turnover times that do not allow for rapid transformations and adjustment to changing contexts (Holdren 2006:6). To cut it short, energy transition is very costly and this remains a big issue for many countries on all stages of economic development.

Why are innovations important?

Technological development of renewables is needed to make renewable energy possible across in various economic and geographic contexts. In general, innovations have long been considered by economists as one of the main drivers for economic growth creating new technologies, jobs and profits. For many countries hit by the 2007-2008 financial crisis such economic rationale is already a ground for supporting innovations of many kinds. Innovating in the field of renewable energy is crucial as we need to come up with new ways of producing energy from previously unused sources (for instance, various kinds of waste or biomass), find the best ways of utilising renewables in certain geographic contexts, and make renewables more widespread (and therefore cheaper and more affordable). Renewable energy innovations are also a needed good for export – renewable technology transfer is a tool to help the world fight climate change beyond national borders.

It is evident that markets alone may not have the resources for research and development funding needed for renewable energy solutions and that the state needs to develop ways to aid the private sector in the development and deployment of relevant technologies (Foray, Mowery, Nelson 2012:1697). While there seems to be a universal agreement on what is to be done to transition to renewables, when it comes down to practice the question of *how* to get there still remains. This is one of the reasons why I chose this topic - there is always space for development in state policies and support tools, even in the most developed

countries like Finland and it is interesting to look at it from the private sector's perspective since that sector is the main beneficiary of such support.

Last summer I worked at the technology and innovation unit of the United Nations Framework Convention on Climate Change that deals with climate technology transfer, i.e. the transfer of technologies that help combat climate change (including renewable energy) from developed to developing countries. During that assignment I realised how difficult it is in practice for countries to create an infrastructure for renewable energy, let alone elaborate effective and, more importantly, cost-effective policies and support tools to facilitate the development and deployment of renewables. I personally believe in top-down rather than bottom-up transitions, and I think that considering the urgency of the global sustainable development and energy transition agenda, now like never before is the time for governments to get involved in it very actively.

1.2 The "entrepreneurial state"

Recently, a big discussion among economists, researchers and policymakers was sparked by Mariana Mazzucato's new concept titled the "entrepreneurial state" (2015c) describing a state that takes a very active role in supporting innovations. In contrast to the traditional neoclassical economic perspective that sees intervention as only necessary to "fix markets", Mazzucato suggests that governments have indeed been and should be instrumental in supporting risky innovations. She supports her argument with a lot of examples of the US state's involvement in some of the most breakthrough innovations of our time, but it remains a big question whether the same logic could be applicable to other countries.

The concept is at the very early stage of development and could benefit from being applied to various sectors, so I decided to look specifically at the energy sector and the development of renewable energy innovations. I have chosen to narrow down my research to the Finnish context as Finland has been acknowledged for its well-developed innovation system and the "entrepreneurial state" literature offers an interesting perspective for studying the role of the state in facilitating this system. The country has also achieved quite a big share of renewables in the national energy mix compared to other European

countries[1]. Moreover, Finland has an internationally acclaimed expertise in cleantech and that sector has been considered as strategically important by the Finnish government (see Chapter 4) so an increased activity in supporting cleantech innovations including renewable energy can be expected in the near future.

1.3 Research idea, question and objective

Based on the motivations expressed above, my research will focus on the topics of innovation, innovation policy, the role of the state in innovation development and renewable energy. The main idea of the research is to explore the state support for renewable energy innovations in Finland in relation to the "entrepreneurial state" concept to determine whether there is space for improving the state activities and whether the Finnish government could achieve the same level of involvement in innovation that Mazzucato is calling for. The "Yes It Can?" in the title of this thesis is related to the former US President Barack Obama's 2008 election slogan "Yes We Can", to show the linkage to the US context and rhetoric on which the "entrepreneurial state" concept is strongly based. The novelty of the study is in the application of the "entrepreneurial state" literature to a specific sectoral (i.e. cleantech/renewable energy) and national (i.e. Finnish) context.

I have designed my research as a qualitative interview study based on empirical data – my main focus for data collection will be the real experiences of the Finnish private sector in developing renewable energy innovations and interacting with the state to receive support for those innovations. The research is worth conducting as it can reveal the real needs of the private sector for state support, identify problems and frustrations and suggest ideas on how state activities can be improved. These findings would be useful as more detailed roadmaps are needed to achieve recently adopted 2030 EU climate and energy policy targets (EC 2017b), as well as international and national sustainable development strategies. Such task seems very ambitious to carry out within the scope of a master's thesis work so the outcome of this research will of course be limited to only a handful of business cases and based mostly on the "entrepreneurial state" perspective on the role of the state in innovation.

I have defined the research question for the study as follows:

[1] More about renewable energy in Finland is explained in Chapter 4.

How can the state support the private sector in the development of renewable energy innovations in Finland?

The research question is exploratory rather than normative – with the "how" phrasing I indicate my goal of revealing current problems and needs that can be articulated by the private sector. I do not intend to produce a normative explanation of the overall organisation of the state support activities in this study since that would require a much larger research scope and perhaps a different methodology.

The "private sector" in the research question refers to Finnish companies (or international companies operating in Finland) engaged in the development of innovations in the field of renewable energy (for instance, solar, wind, geothermal or bioenergy). These are not necessarily energy companies or electricity producers and can also be, for instance, manufacturers of technical equipment or oil companies.

The "state" refers to the organisations that represent the Finnish authorities in charge of developing and executing innovation policies and support instruments. By "support" I mean the Finnish government's policies and tools introduced to support innovations, e.g. taxes, subsidies, grants, etc. There are two major organisations in Finland that could be placed in this category – the Ministry of Economic Affairs and Employment (TEM) in charge of innovation and energy policies and the Finnish Funding Agency for Innovation (Tekes), owned by the same ministry. There is one more organisation that deserves attention but it does not officially represent the Finnish state – the Finnish Innovation Fund (SITRA). It shapes the Finnish economic development agenda and has been involved in some innovation funding. In terms of policymaking in the field of renewable energy innovations, there are also more state actors involved including other ministries (e.g. the Ministry of the Environment) and research institutions (e.g. The Academy of Finland, VTT) but in this research I refer to the "state" with mostly policymakers from the TEM and Tekes in mind.[2]

Resting on the presumption that Finland is a pro-market economy, in this study I see the private sector as the driver of the economy and the beneficiary of state support, so its need

[2] My original idea was to interview the representatives of TEM and Tekes to find out more about policymaking processes and how the state works with defining what kind of support is needed specifically for private sector developing renewable energy innovations. However during the research they have been very difficult to reach so I have based my knowledge on the policies in this field through secondary data. The overview of Finnish renewable energy policies and tools can be found in Chapter 4.

for support is considered prime in forming the basis for designing policy, not vice versa. Therefore even though the state might design renewable energy policies with targets based on what the international scientific community says on climate change, in this study I am taking the private sector's point of view on how tools for support should work and which roles the government should play in renewable energy innovations.

The main objective of my research is to develop a set of recommendations for Finnish policymakers on how to improve public support for renewable energy innovations. The recommendations will be based on experiences, frustrations and opinions expressed by company representatives in the interviews. I will also look at the recommendations through the prism of Mazzucato's "entrepreneurial state" conceptualisations. The recommendations are aimed at Finnish policymakers working on innovation and energy policies and tools for the promotion and support of renewable energy.

2 LITERATURE REVIEW

In this section, the main theoretical foundations of the study are explained. The main material for this study was found in economics, innovation, science and technology literature which describes the development of innovations and the role of the state in the economy and innovation.

I first lay out some general terms that I use extensively throughout the research – "innovation", "renewable energy" and "state support". Since Mariana Mazzucato's "entrepreneurial state" is a very new concept, it is better understood in comparison with earlier concepts explaining the role of the state in the economy, so I first explain how orthodox economics' market failure theory explains state intervention. I then turn to alternative economic thoughts based on the evolutionary economics literature and explain what the "national systems of innovation" concept is and how it has been used by policymakers. After that I briefly mention mission-oriented policy literature that is less of a theoretical concept but is nevertheless relevant to this study and Mazzucato's research in respect to the grand challenges of climate change and energy transition that renewable energy innovations can help tackle.

The main part of the literature review covers different aspects of the "entrepreneurial state" discussion like the role of the state in the innovation system, risk and reward relationship in state investments, policy implications of the "entrepreneurial state" and more specifically the application of the "entrepreneurial state" in the cleantech sector. I also summarise the main critique of Mazzucato's research which identifies the main gaps of the concept. I conclude the review with a brief summary of all described concepts and the explanation of the role of literature in this study.

What is innovation?

"Innovation" is a well-known term among economists but recently it has become a buzzword used more and more frequently also among policymakers, marketing specialists, management consultants and many other practitioners as not only a scientific concept, but also a metaphor, a political promise and a slogan (Kotsemir & Abroskin 2013:3). This makes it more difficult to give a single definition of innovation in the current times, when the economists have also developed different conceptualisations of it. During the "golden era" of innovation research in the 1960s-1980s, innovations were seen mostly as

technological inventions but more recent definitions imply that innovation may be based on improvements of non-technological type as well. The OECD (2005:46) gives the following definition of innovation:

> "Innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations".

Sengupta (2014:37-38), for instance, lays out four forms of innovation: technology-based innovations; knowledge diffusion and human capital based innovations; introduction of new combinations; and innovation as evolutionary learning. Another typology of innovations that is quite well known is the one by Freeman and Perez (1988) where they defined incremental, radical, system and techno-economic paradigm type of innovations based on the technological change they bring.

In this study I am mostly looking at innovations that may be placed into the technology-based and incremental type since I focus on the renewable energy where so far innovations have usually taken the form of new technological developments. This is quite similar to Mazzucato's "entrepreneurial state" as she also looks at some of the most breakthrough technological innovations in her research. To summarize, this thesis defines "innovation" as a technological improvement of a renewable energy technology developed into a commercialised product.

What is renewable energy?

Renewable energy is a kind of energy derived from natural processes that are replenished at a higher rate than they are produced (IEA). These natural processes can be, for instance, sunlight, wind, tides or heat contained inside the Earth's depths. The main types of renewable energy (also referred to as "renewables" or "RE" in this thesis) developed to date include wind, solar, hydro, tidal, geothermal and biomass energy (EC 2017c). Common RE technologies promoted nowadays include solar panels, wind turbines, geothermal wells, biogas and biofuel. In this thesis I focus on innovations in the fields of wind, solar, biofuel and geothermal renewable energy.

What is state support for innovation?

The "state support" in this study refers to policies and policy instruments the state elaborates to help organisations (those can belong to private sector, public sector and the so-called "third sector" too, i.e. NGOs) to develop certain technologies, projects or activities. In this sense, "state support" is synonymous with "public support" and also "industrial policy", the latter being a term often found in innovation, science and technology literature. State support for the private sector most commonly refers to research and development grants, subsidies, tax breaks, state investments, loan guarantees and so on.

State support in market economies is usually given to the private sector to facilitate the development of innovations but not to create it or lead it. In other words, support tools supplement the current market context, although their development is the choice of the government, and so is the degree of ambition in industrial policies.

What kind of state support for innovation may be needed to transition to renewable energy? Holdren (2006:20-21) argues that nowadays policymakers need to elaborate new major policies aimed at providing a bigger scale for research, development and demonstration of new energy technologies; financing the early stages of market entry for new technologies; putting effort into the diffusion of new energy technologies to less developed countries; devising a global framework for limiting greenhouse gas emissions; mobilising the power of partnerships between state, private sector, academia and NGOs; and communicating the need for energy transition to the broad public. In this thesis I narrow down my focus by looking at state support for RE innovations in Finland (see p.43).

2.1 "Fixing markets": how orthodox economics sees the role of state in the economy

Since this thesis focuses on the role of state in innovation, it is worth first explaining how it has been treated by traditional economics before delving into alternative concepts.

In orthodox economics, where markets are seen as the main actors of economic activity and growth, a state intervention into economy is justified only if markets fail, that is, if they fail to allocate resources efficiently. This theory is often referred to as "market failure

theory" and it suggests that the role of the state is to correct market failures or "fix markets" by, for instance, investing in public goods, e.g. research. (Arrow 1951.)

Mazzucato and Penna (2014; in Mazzucato 2015a:4) present a typology of market failures. There are coordination failures, for instance miscoordination of capital that the state could "fix" by increasing investment. There are public good failures, e.g. in knowledge, that often make governments elaborate industrial policies to promote public investment in, for example, goods that are underproduced, for example research or infrastructure. There are information failures related to the lack of knowledge of what the private sector needs for support (e.g. financing) and imperfect competition failures. Another type of market failure can be negative externalities – one relevant example is climate change, seen as a negative externality from carbon-intensive production activities. In case of negative externalities, the state may "fix" the markets by introducing market-based mechanisms (e.g. carbon pricing) or tax breaks, but the direction of change (for instance, the implementation of the energy transition) is still left to the market forces.

In the market failure theory, innovations are assumed to be driven by entrepreneurs and at best the public sector can only "facilitate" them (Mazzucato 2016). The state therefore assumes a very limited role of a facilitator of the innovation system without the role of directing the economy or "picking winners", i.e. supporting promising businesses (Mazzucato 2015a:2). Mazzucato (ibid.) states that the market failure approach is useful for steady state economy scenarios when the state is "putting patches on existing market" but less useful when a new market needs to be created and shaped (like in the case with cleantech or, more specifically, renewable energy technologies), as it cannot justify big transformative investment needed for a transition of the economy on a large scale.

Posing a question on what role the state could play in innovation development, Mazzucato (2015a:2) criticises the market failure theory for the absence of embodied directionality that is needed to direct societal change, e.g. decarbonisation. In her opinion, under the market failure theory, the state is not considered a lead investor and market creator and therefore the theory offers no insight into how to structure public organisations to provide high-risk investments. Moreover, the distribution of risk and rewards between the state and the private sector is not put under question and therefore it is unclear whether the government could benefit from investing in business. Overall, it can be concluded that fixing market failures is quite an outdated economic approach which can no longer be

much useful in explaining the role of state in supporting innovations for grand societal imperatives like the transition to renewable energy. In recent decades, new approaches to explain innovation development and innovation policies were developed by economists that offer some new perspectives on the topic – I will briefly introduce some of them below.

2.2 Evolutionary economics: an alternative

Another approach to the question of the rationale of state intervention in innovation activities is evolutionary economics which calls for government measures in addressing system failures, that is, lack of coherence between institutions of an innovation system (Kauknes & Nordgren 1999:iii). Evolutionary economics sees technological change and innovation as the most important factor of economic evolution. It pays attention to the dynamics of advanced economies and the learning that takes place across organisations, their functions and within an innovation system in general (Kauknes & Nordgren 1999:6-7).

The evolutionary economics approach is grounded in empirical observations and its key concepts are "technological paradigms" and "technological trajectories" (Dosi 1982; Nelson & Winter 1977). It sees market forces as incapable of directing system change when a new technological revolution emerges (e.g. increasing use of renewables globally), so the approach calls for building new institutions to diffuse the new technological paradigm (Mazzucato 2015a:8-9). As the evolutionary approach recognises innovation as a process involving many actors interacting in a complex institutional system, it calls for policies to alter the structural condition of such system (Kauknes & Nordgren 1999:7-8).

National Systems of Innovation

Probably one of the most well-known concepts in evolutionary economics is the "national systems of innovation" (hereinafter "NSI"), developed more than 30 years ago in parallel by scholars in Europe and the USA (Lundvall 2007:95). The NSI intended to provide an alternative to explain the dynamic processes related to innovation and learning that standard economics cannot explain. The NSI was developed to aid both theory and practice so it could be "a different perspective on economic policy where innovation and learning were seen as important processes behind economic growth and welfare" (Lundvall

2007:97). The concept was developed from empirical data on the grounded theory methodology but it is still unclear whether it originated from economists or policymakers and therefore to what extent it could be as theoretical as orthodox economics and its conceptions of market failure (Sharif 2006).

National systems of innovation can be defined as the "network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman 1995). The "system" part of the term refers to the interaction of actors being more than just the sum of their activities – together the system actors are able to produce innovations while benefiting from co-evolutionary, self-organising and learning process inside the system (Lundvall 2007:100-110). In other words, the focus of the NSI approach is the interaction of firms with each other and with the knowledge infrastructure, i.e. linkages between institutions.

Since its inception, the NSI approach has been used ex-post by policymakers as a tool to describe well-developed innovation systems in countries like the USA, Japan, Brazil, China and also some less-developed ones (Lundvall 2007:97,112). In fact, Finland was the first country that adopted the NSI approach as a basic category of science and technology policy (Sharif 2006:745). Since the "national" component is deliberately embedded in the concept, the NSI has also been used to compare the countries' competitiveness by assessing their innovation systems.

Stirling (2008; in Mazzucato 2015a:2) criticises the NSI approach for not being explicit enough as a solid alternative to the market failure framework to guide economic policy. Sharif (2006:760) thinks the approach lacks clear structure and often ends up being a tool to provide descriptions rather than explanations, therefore not being very operational for policymakers. Since NSI focuses on the linkages between institutions, under this approach the state is often seen as the facilitator, i.e. an actor with quite a passive role in innovation. To conclude, NSI is not that instrumental in explaining what role the state could play in an innovation system of a given country. However, as a well-known tool used by Finnish policymakers, this concept can act as a touchpoint in interviewing people related to innovation policies in Finland which is part of this research (see p.36).

2.3 Mission-oriented innovation policies

A lot of the innovation policy literature is filled with examples of breakthrough innovations from, for instance, the defense industry in the US for which publicly funded programmes were put up to achieve specific objectives[3]. Nowadays some researchers talk of mission-oriented policies as a way of looking at solving grand challenges, e.g. climate change. In the context of this research, for instance, the "mission" for the state could be achieving a 100% renewables energy mix.

Mazzucato (2015a:7) does not contrast mission-oriented policy literature to market failure theory approaches, as in her opinion, mission-oriented policies are too empirical to provide solid justifications for the state investment in innovation. She posits that mission-oriented policies do not look at agencies for innovation support (e.g. development banks), and are not that useful in understanding the role of state in the innovation process. Some authors, for instance Foray, Mowery and Nelson (2012) are skeptical about solving clean energy challenge by mission-oriented approaches of the past. Holdren (2006; in Hargadon 2010:1025) argues that the energy sector's innovation challenge is considerably bigger than innovation missions of the past due to enormous costs of replacing the energy system and 30-40 years of turnover time. However, in relation to this study, the mission-oriented policy approach may be useful for looking at how Finnish policymakers and the private sector perceive the transition to renewable energy.

2.4 The "entrepreneurial state": a new concept?

The concept of the "entrepreneurial state" originated from Mariana Mazzucato's homonymous pamphlet published in 2011 by the UK-based think tank Demos. The pamphlet intended to contribute to the discussion about the role of the state in the development of innovation as the main driver for growth and provide some recommendations on improving innovation policies for policymakers in the UK. In the publication Mazzucato argues that the entrepreneurial role of the state as a leader in innovation often goes unnoticed. She called for unpacking that role and therefore elaborating recommendations for making current innovation policies more effective (Mazzucato 2011:21). After publishing the pamphlet, Mazzucato continued her research

[3] For instance, US government-sponsored Manhattan Project on nuclear weapons or Project Apollo on human spaceflight. (Foray, Mowery, Nelson 2012:1697)

and in 2013 published a book *"The Entrepreneurial State: debunking private vs. public sector myths"* where she backed up her thinking with examples of the US state's involvement in innovation. She subsequently published various working papers on the topics of "entrepreneurial state" and innovation policies as part of her SPRU[4] professorship that I have also used in this study.

What new thing can a concept like this offer when a multitude of concepts alternative to the market failure theory already exist? A new concept describing the role of state in innovation is needed, Mazzucato maintains, "to meet societal challenges and achieve the goal of smart, innovation-led growth"; such a concept would look beyond the assumptions of market failure theory and offer a new perspective that is better linked with the economic challenges of the present world (Mazzucato 2016:101).

Mazzucato begins by suggesting that the current perception of the state is largely inaccurate. The state, she writes, is perceived as a "wealth extractor and distributor" and a big spender of taxpayers' money with no leading role in innovation and production (Mazzucato 2011:23; Mazzucato 2015c:4). This is amplified by the media, business and pro-market politicians who present it as a "sluggish, bureaucratic, inertial, 'meddling' public sector" (Mazzucato 2011:17). The perception of a "lazy state" is usually contrasted with the private sector that is perceived as dynamic and often given credit for true innovation developed by entrepreneurs with the help of private venture capital, like in the case of the Silicon Valley innovation cluster in the US (Mazzucato 2015c:2,51). Research and development, small firms and patents are often considered other key drivers of innovation, however, Mazzucato calls for debunking the "it's all about R&D" and "small is beautiful" myths (Mazzucato 2015c:172-174) and getting rid of the general assumption that the state should stay away from unleashing the power of entrepreneurship and innovation in the private sector (Mazzucato 2015c:21).

The misleading perception of the state's role in innovation is perhaps blinding economists, policymakers and the general public from understanding the actual role of state, which Mazzucato suggests, really needs to be reconsidered. She argues that in the US, it was in fact the state agencies that provided the initial push and early stage high-risk funding for some notable technologies like the Internet and many technologies that led to Apple's

[4] Science Policy Research Unit at the University of Sussex (UK) is an internationally recognised leading centre of research in science, technology and innovation policy. Source: http://www.sussex.ac.uk/spru/about

iPhone, and later also the e-car manufacturer Tesla (Mazzucato 2015c:154). The state can also be credited for risk-taking and radical growth as well as the institutional environment that fostered technological change (Mazzucato 2011:23).

If we can understand the role that the state has played beyond merely "fixing" the markets, we can build a new theory on how the state can actively create and shape new markets (Mazzucato 2015c:15). Mazzucato and Penna (2014; in 2015a:.9) suggest that historically businesses enter new sectors only after high uncertainty, which is also true for cleantech. In Mazzucato's view, it is the state that can fill in the period of this high uncertainty - create and shape new markets based on technologies that are too risky for private sector to develop from scratch (Mazzucato 2015c:4,30). For this, not only technology-specific and sector-specific expertise is needed but also an exciting vision of the state's role that can recruit such expertise (Mazzucato 2015c:11).

Mazzucato is adamant that we need the government to think big about innovation. An "entrepreneurial state" is a courageous state that invests rather than just spends, directs growth and sparks innovation beyond the private sector (Mazzucato & Perez 2015, Mazzucato 2015c). It is a government that envisions a direction for technological change and creates a network of willing institutions that seize opportunities through public-private partnerships. It is "entrepreneurial" as it is not afraid to experiment, learn and fail like many entrepreneurs do (Mazzucato 2015c:5).

Mazzucato writes that the perception of government failure should be reconsidered, too. Usually state failures are attributed to governments not knowing how to "pick winners", i.e. how to make the right choices which firms or sectors they should support so the states risk wasting money in wrong investments (Rodrik 2014:472). Mazzucato adds, that in many cases state "failures" happened when the state took up a difficult job like trying to help drive a mature industry or trying to launch a new technology sector (Mazzucato 2015c:25). Being an "entrepreneurial state" requires admitting that the state plays a leading role in innovation and therefore has to accept the massive risks inherent in innovation activities where failure is often inevitable (Mazzucato 2015c:21; Mazzucato & Perez 2015).

A good system of innovation is not enough

Mazzucato writes that it is important to recognize the "collective" character of innovation, i.e. that innovations are developed by a network of different types of businesses, financial and educational institutions, the public sector and others. While arguing for an "entrepreneurial state", she turns to the national systems of innovation concept which she deems relevant since recently there has been an increasing reliance on horizontal innovation systems that slowly transform into open innovation systems where boundaries between public and private sector are increasingly blurred. (Mazzucato 2015c:207)

Mazzucato notes that not only the importance of innovation systems need to be recognised but also the role of each actor in it (ibid.). Having a functional national system of innovation that is rich in networks is not enough (Mazzucato 2015c:46). An "entrepreneurial state" is a state where a solid system of innovation is catalyzed by "proactive, flexible, decentralized action on the part of government" and where the state is a major player (Mazzucato 2011:22; 2015c:45-46). The leading role of the state in the innovation system is further fulfilled by its effort in mobilizing resources to diffuse knowledge and innovation across the economy as well as driving existing networks or developing new ones that bring together diverse groups of stakeholders (Mazzucato 2015c:45-46). However, the "entrepreneurial state" is not just about a state fixing failures in the innovation system or markets – it leads industrial development by picking strategic priority areas and developing strategies for technological advances in those areas (ibid. p.47).

Should the state be rewarded?

Taking risks is one of the main characteristics of an "entrepreneurial state." Perhaps, one of the most interesting questions found in Mazzucato's research relates to the risk and reward relationship in the state's investment in innovation. It can be argued that the state gets returns on its investments through the knowledge spillovers that benefit the economy, or the tax income – generation of new jobs and taxes paid by private sector. However, those are quite indirect ways and the possibility of more direct ways for the state to reap rewards is often ignored (Mazzucato 2016:108).

The basic idea is that a state is able to generate return on investment like many private sector actors do. In Mazzucato's mind, the return-generating system of the state is broken,

so special effort is needed to develop direct mechanisms of getting rewards for the state so that some kind of "revolving fund" could be created to cover for losses due to high uncertainty of innovation (Mazzucato 2015a:10). The idea is not far-fetched – the government owns some of the value it created by investing in promising technologies with growth potential over time, and invests those funds later into new potential innovations (Mazzucato 2016:108). The state can, for instance, retain equity in the companies it supports – in fact, Mazzucato often gives the example of the Finnish SITRA (see p.47) that retained equity in its early-stage investments in Nokia (Mazzucato 2015c:205). Another way of reaping direct returns is to give out loans and guarantees with conditions, so the private sector is required to pay back a portion of it over time (Mazzucato 2015b:124).

Mazzucato (2016:113) argues that in terms of state investment, what is lacking at the moment but really needed is "patient finance", i.e. long-term capital for innovation, that is lacking at the moment. One form of "patient finance" is, for instance, a feed-in tariff when energy sector is supported by prices higher than the market average (see p.43), another is state investment banks – specific institutions put up to manage mission-oriented state investments (Mazzucato 2016). The state, Mazzucato suggests, would benefit most from a portfolio approach to investment in innovation, that is, investing in several projects and covering losses in unsuccessful ones with the return from the successful ones (Mazzucato 2015b:124). Even though there are already existing ways for the state to get rewarded for its investment in innovation, figuring out the best ways of organising it remains a big challenge and, as suggested by Mazzucato (2016:109), will not happen until the leading role of state in generating economic growth is realized.

Policy implications of the "entrepreneurial state"

An "entrepreneurial state" needs to be supported by policy frameworks that help guide investments, however keeping in mind that state investments should not "crowd out" private investments (Mazzucato 2016:113). First, Mazzucato (ibid.) writes, the policymakers need to recognise that markets depend on choices made by both private and public sectors as often public policies include a direction defined for certain industries. Perez (2002 in Mazzucato 2015c:6) suggests that the state through strategic decision making should drive the economy to new "techno-economic paradigms". Governments should no longer rely on markets to run the world but learn how to create and shape new markets and make innovation a growth policy and vice versa (Mazzucato & Perez 2015:2).

Mazzucato (2015c:31) is calling for "entrepreneurial state" policymakers to be courageous in not only supporting selected private sectors but also requiring a higher commitment to innovation from them. She suggests that rather than funding small companies with the hope that those will grow, the state should contract young businesses that demonstrate ambition (ibid.:53-54).

One of the most important policy implications of the "entrepreneurial state" is that new kinds of innovation policies must be strong in defining directions, i.e. identifying key drivers of growth in the future, which the private sector can later pick up (Mazzucato & Perez 2015:4). Another thing that Mazzucato (2015a:15) outlines as important to consider within the call for new innovation policies is organisational change, i.e. how public organisations can be structured to allow risk-taking, and evaluation – understanding the decisive role of the state in the economy and translating it to new indicators for evaluating public policies.

Green entrepreneurial state

In her research Mazzucato calls for the "entrepreneurial state" logic to be applied to the cleantech sector. This industry, she maintains, is still in the early stage of development with a lot of market and technological uncertainty. In her opinion, it cannot be developed by market forces only since markets do not value sustainability. (Mazzucato 2015c:127.)

Mazzucato points out that from the beginning of 2000s the states have already played a very important role in shaping the cleantech sector by providing R&D support to improve energy technologies and modernize grids, as well as to ensure competitiveness for renewables as they were being introduced to markets (ibid.). She goes as far as stating that "no leading cleantech firm emerged from pure 'market genesis'" (ibid.:154). That support continues in the present day and enjoys momentum from the international community with an agenda to combat climate change, and Mazzucato (2015d:2) gives credit to countries like Germany, Brazil and China with their state development bank practices for leading the transformation to green energy.

The involvement of state in supporting green energy innovations must stretch beyond R&D support as the challenge in this sector also lies in the later stages of innovation development, namely market diffusion, for which state development banks are important (Mazzucato 2015d:4-6). Mazzucato and Siemeniuk (2016:9) note that many of the

renewable energy technologies are already developed and what is really needed is high-risk funding for the private sector to support their commercialization.

Several states, including Finland, are already investing aggressively to promote the cleantech sector but it is also important to sustain this momentum and make sure investment policies are laid out on a long-term basis as transformation to clean technologies will take considerable time (Mazzucato 2015d:10,25).

The support of "green" innovations should include both supply-side and demand-side policies (ibid.:25). The former include, for instance, tax credits, subsidies, loans, grants, pricing schemes, information brokerage and networking, R&D contracts, and the latter – environmental regulations, public procurements and policies that affect energy consumption patterns (Edler & Georghiou 2007 in Mazzucato 2015d:5; Mazzucato 2015c:121-122).

To sum up, an "entrepreneurial state" is a state that is visionary, proactive and risk-taking. It creates effective networks of actors that harness the private sector over the long-term time horizon with a clear direction in mind. It is the lead investor and orchestrator of innovation systems and a creator and shaper of markets, often during their conception when uncertainty is too high to leave this job to markets.

2.5 Critique of the "entrepreneurial state"

The "entrepreneurial state" sparked a big discussion among economists and policymakers and not without criticism. Although the concept is still very young, some important points have already been made by researchers and media.

Mazzucato's research is very empirical and a large portion of criticism is related to the evidence she uses to support her argument. Mingardi (2015:603-607) thinks that her historical evidence of the state having played an important role in innovation is shaky, not robust enough and seems more of an ex-post rationalisation of different policies that were not necessarily meant to be strategic and promote particular innovations. In fact, the whole book[5] is focused on the United States, which Mingardi thinks was a strategic choice since the country is known as a big advocate of the free-market economy and showing that the

[5] Mazzucato, M., 2015. The Entrepreneurial State: Debunking Private vs. Private Sector Myths. Revised Edition, New York: Public Affairs

US state, not just markets, is to be given credit for innovation, too, would offer a new interesting perspective (ibid. pp.604-605). The idea of the US government supporting innovation, Mingardi mentions, is nothing new as researchers like Uselding (1993:163 in Mingardi 2015:605) have pointed out that the US state "has encouraged innovations and their diffusion throughout most of [the US] history" (Mingardi 2015:605). While Mazzucato is very articulate in proving that the US state has indeed been active in innovation support, she only briefly mentions industrial and innovation policies in Europe, however the "entrepreneurial state" concept would benefit a lot from empirical data on many European contexts, especially because some of the European countries were ranked as the world's most innovative ones[6].

Perhaps one of the reasons why Mazzucato's research raised such a big discussion is because most of her "entrepreneurial state" research is based on examples of innovative products we cannot imagine our lives without like the Internet and GPS or lucrative products like Apple's iPhone or Tesla's electric car. Especially in the case of the latter two, it is often those companies' entrepreneurial leaders who are given credit for developing much wanted products and Mazzucato debunks that myth by offering evidence that in the early stages, it was actually the US government that provided big support for those companies' R&D. Westlake (2014), however, argues that Mazzucato fails to acknowledge that it was still the business acumen of Apple that helped put notable technologies together into a product like the iPhone, so Mazzucato should not overlook the fact that it is often the private sector that is key to transforming inventions into commercial products. As per other examples of innovations in the "entrepreneurial state" research, Mingardi (2015:609) argues that those innovations are rather a "positive externality of public intervention, as opposed to carefully designed outcomes of industrial policies" that are the key hero of Mazzucato's study.

Mingardi (2015:616) writes that one can understand Mazzucato's work as an attempt to solve the modern economic riddle of where innovations actually come from and her answer generally is that they come from government investment in R&D of new technologies. To this, Westlake (2014) makes a point that – especially in the Apple example – Mazzucato overlooks the intangible investments the private sector puts effort in

[6] The Global Innovation Index (https://www.globalinnovationindex.org/) ranks the US as the 4th most innovative country in 2016. Top European countries are: Switzerland (1st), Sweden (2nd), the UK (3rd), Finland (5th), Ireland (7th), Denmark (8th), the Netherlands (9th) and Germany (10th).

to make marketable products out of innovations – design, new business models, marketing and product development. R&D investment does not involve these, so in Westlake's opinion, this understates the role of businesses in taking big risks of introducing innovative products to the market (ibid.).

With the "entrepreneurial state", Mazzucato intends to contribute to the discussion on the role of the state in the economy. She departs from the state as a corrector of market failures, but that, Mingardi points out, theoretically should not include state interventions in healthcare, education, competition, environmental regulations, energy and so on, that can already be found even in such a pro-market economy as the US (Mingardi 2015:606). Mazzucato is being too strong on thinking that the states have a very ideological approach to "fixing" markets although state motivations can be driven by visions and ambitions to have a more innovative economy (ibid.). Another theoretical flaw of Mazzucato's may be that she focuses almost only on technological innovation and thus industrial policies, whereas innovations take different forms and do not necessarily equate technological progress or have to become "products" on the market (Mingardi 2015:622).

A part of the critique relates to Mazzucato's discussion of government spending, risk and rewards relationship. Westlake (2014) notes that it is quite perverse to ignore that tax income is already a significant reward the government gets indirectly from the investment in innovative businesses. Kubik (2014) is skeptical of how the "entrepreneurial state"'s suggested mechanism for allocating investment funds is superior to the profit and loss logic of the markets. Mingardi (2015:612) laments that Mazzucato often assumes that the existence of state funds is already a condition for successful investment, however in reality the allocation of funds may depend a lot on state institutions and ways of allocation per se (e.g. competitive or noncompetitive).

In the criticism of Mazzucato one may find that a lot of the blames she puts onto private sector is also blamed on the state. Both The Economist (2013) and Mingardi (2015:612) do not agree with blaming only private sectors in short-terminism as they think the state often acts on short-term basis too. The Economist (2013) reminds that the state spending can often be wasteful and suggests the example of many countries imitating the US's Silicon Valley, which does not bring the same results. The reason for the government to be a bad entrepreneur is in the conditions it is operating in, including the fact that state income is guaranteed by taxes in an indefinite timeframe whereas private sector investors, for

instance, stop investing when their money runs out (Mingardi 2015:618, The Economist 2013). What Mazzucato especially lacks in her study, is demonstrating how government bureaucracy may be overcome by appointing the right planners and engineers that do not "crowd out" the private sector and its investors (Mingardi 2015:619).

The "entrepreneurial state" is largely targeted at policymakers but it remains a big question whether the study informs policy in a useful way. In Westlake's opinion, Mazzucato's suggestions on "entrepreneurial" state spending on innovation are quite problematic as they are difficult to administer in practice. For instance, charging returns on the the investees is not just tricky to organise but is probably an unwelcome idea as businesses also invest in innovation themselves (Westlake 2014). He continues by saying that the most entrepreneurial states like Finland, Israel or the US usually get their money back with interest but not an equity share (ibid.).

Another question may be posed to what sectors Mazzucato's "entrepreneurial state" can actually be useful for. Having provided examples on high-tech and pharmaceuticals, Mazzucato turns to the cleantech sector, but Kubik (2014) comments that it is too easy to talk about the "entrepreneurial state" supporting green energy when in the recent decade many states have already aggressively supported it as part of the growing climate change agenda. It comes down to somewhat of a chicken-and-egg problem of whether it was the states that picked up the cleantech direction on purpose or if it was the worried international community (e.g. climate scientists) that encouraged the states to include cleantech in their strategic plans.

The "entrepreneurial state" focuses on the supply-side policies but the demand-side policies and the demand of consumers are very important, too. Mingardi says that Mazzucato has missed the fundamental fact that in a market economy, consumers are very influential and – beside the state and the private sector – also have the power to shape the economy. It is in this sense that her claim that states "pick winners" better than the market is wrong because consumer demand can also "pick winners". (Mingardi 2015:619,623)

Much of the critique also suggests that in general, it is very bold of Mazzucato to claim that it is the state who makes innovations possible (Mingardi 2015:605), since innovation is a complex process involving a range of institutions and it probably does not make sense trying to trace back what kind of actors play a bigger role. The "entrepreneurial state" is a very ambitious vision of a state, however Mazzucato (2015d:31) is aware of this as she

points out that the state's capacity is not to be romanticized and in fact, it must be made sure that the state is made accountable and democratic in the way it leads innovation.

Since in this research I look at innovation theories and the role of state in innovation, I think that the most important critique on Mazzucato is actually that the concept of the "entrepreneurial state" is rather stated than explained, i.e. it is not clear how exactly a state can become a leader in innovation (Mingardi 2015:610-611). The Economist (2013) writes that the study does not answer why some states have been successful in supporting innovations and some not, although it is not clear if Mazzucato intended to answer that question.

Criticism aside, Mazzucato's work has been praised for pointing out that the state has a role, too, in creating technological breakthrough and that if not celebrated, that role should be at least understood. The discussion of the "entrepreneurial state" is still on point – The Economist (2013) concludes that "There are many reasons why policymakers must modernise the state and bring entitlements under control. But one of the most important is that a well-run state is a vital part of a successful innovation system".

In my opinion, Mazzucato's research offers a very interesting perspective on the role of the state in innovation. I agree that it has often been overlooked and perhaps we need to reconsider our perception of what the state could and should do. However, I think that the negative perception of the state is already not the case in the Nordic countries, including Finland, so the "entrepreneurial state" really needs to be checked for European contexts. The "entrepreneurial state" is at a very early stage and, to my mind, cannot yet be put in the same set of alternative innovation concepts that I explained above in this review; it is indeed a conception rather than a solid concept or theory. What I think it needs most is empirical evidence from contexts where political and economic environments are different, as well as time (maybe a couple of decades) to prove or deny whether the state's "entrepreneurial" action can lead to breakthrough innovations in the global fight against climate change.

2.6 Summary of the literature review

In this literature review I have outlined key concepts on innovation and the role of state in innovation that are useful to understand the "entrepreneurial state" discussion. They cannot

theoretically be compared along the same lines, however below I have summarised them very briefly based on their main focus and the policy implications for the state in Table 1:

	Main focus	**Role of the state and policy implications**
Market failure theory	Role of the state in the economy	The state should only intervene in case of market failures, otherwise the state should not take an active role in economics
Evolutionary economics	Co-evolutionary and learning processes of institutions involved in innovation	The state addresses the system failures of the innovation system, policies improve structural conditions of such system
National systems of innovation	System of various institutions and other actors on national level that through interaction develops innovation; processes of learning and knowledge sharing between institutions; vertical and horizontal networks of actors for particular innovation projects	The state is one of the actors in the innovation system and the main facilitator of the system creating conditions for it to operate
Mission-oriented policies	Innovations needed to achieve large societal, economic or political missions, often based on grand challenges	The state invests aggressively in strategic innovation programmes designed to help the country achieve a mission
"Entrepreneurial state"	The role of the state in leading innovation in the economy	The state is an active leader, risk taker and investor in the private sector; it is the lead actor of the national innovation system and a visionary with strategic sectoral agendas

Table 1. Summary of key concepts in the literature review

The orthodox economics and its perception of state that only "fixes" the markets is a starting point of Mazzucato's discussion on the role of state. The market failure logic was challenged by the evolutionary economics stream that focused on systemic aspects of creating innovation in economies, based on the interaction of actors and their mutual learning and co-evolution. That stream also produced the concept of national systems of innovation that gained wide popularity among policymakers and was used (and is still used) extensively to describe how various countries facilitate institutional frameworks for innovation. In Mazzucato's opinion, not any of these concepts are any longer relevant to describe the very active "entrepreneurial" role of the state in the creation of technological innovations that shaped today's economy and she proves it using examples of the US state support for innovation. However, the concept of the "entrepreneurial state" is still being shaped, so more structure to what an "entrepreneurial state"'s policymakers should do for

leading innovations as well as more evidence from other countries on the role of the state are needed.

The role of theory in this study

In this study I see the "entrepreneurial state" not as a theoretical concept that explains the success of breakthrough technological innovation due to government involvement but rather an imperative for governments to become more active in the support of innovation. I connect this with the imperative to fight climate change and Mazzucato's plea to invest more in the cleantech sector and try to apply her "entrepreneurial state" themes (like investment, leadership of the state in the national innovation system, need for new policies and others) to the Finnish context, which, I hypothesise, is very much different from the US context.

While the "entrepreneurial state" is trying to debunk the myth that government has not been instrumental in developing the innovation, I have no intention to take a stand on the government vs. private sector discussion; I rather see an actively involved government as a starting point for this research. What I am really interested in is the question of "what next?" or how to in fact organise that government activity – the missing piece of the "entrepreneurial state" framework as suggested by its critics.

My idea to a certain extent is also to find out whether there is a need for an "entrepreneurial state" in the private sector's opinion. We may generally agree that states need to become more active in supporting energy transitions but in market economies it is still worth finding out what the private sector actually needs and how not to end up with disorganised "entrepreneurial" efforts of the government. The market failure theory, evolutionary economics, national systems of innovation and mission-oriented policies all offer certain perspectives which I find useful for looking at the interaction of the Finnish government and the private sector and I use those as additional themes in the research interviews. I also intend to use the main themes found in Mazzucato's research as the basis for the main outcome of this study – recommendations for policymakers on how to better organise renewable energy support in Finland.

3 RESEARCH DESIGN

This chapter provides a description of the methodological foundations of the study. I start by outlining the research process and then explain the theory behind interviewing, the main methodology used in this research. I then describe the data collection process, including the description of two interview sets with explanation of the objectives and sampling method for each. Data analysis, including thematic analysis methodology and coding process are then explained. The chapter ends with considerations on research limitations and ethics.

3.1 Research process

Kvale and Brinkmann (2009:19-20) suggest several key stages of interview study: thematizing, designing, interviewing, transcribing, analyzing and reporting. Moving from thematizing (i.e. defining research question) to reporting may be perceived as linear process yet some authors also suggest that qualitative interview research is rather open-ended and may depend on the interview subjects. While these stages can serve as general steps for executing the study, I personally resonate more with an interactive research design as suggested by Rubin and Rubin (2005), allowing for continual adjustment to new circumstances on the way depending on the research interview experiences.

There are certain stages of research I have outlined for myself in the beginning to guide me through the study. First, as part of thematizing I have conducted an extensive literature review to build up a solid theoretical and contextual understanding that was useful in the later stages of research. The next stage was defining and narrowing down the research question. I then moved to data collection, i.e. conducting desk research and the interviews. During that stage I have continued reviewing the literature and I have also readjusted my research question based on the interview process. That stage was then followed by the data analysis part in which I put all my findings together. The final stage of the study was making conclusions, assessing the research as well as defining its practical implications.

3.2 Research method

My research is designed as a qualitative interview study focusing on unveiling the experiences and perceptions of state support for renewable energy through conversations with the representatives of the private sector. Kvale and Brinkmann (2009:12) attribute the rising popularity of qualitative methods to what they call a "qualitative stance" from which the world phenomena are "described before theorized, understood before explained, and seen as concrete qualities before abstract quantities". Although a lot of abstract economic theories exist on innovations and state intervention in the economy, I would say that Mazzucato's research follows this "qualitative stance" and is very empirical – it is rather a description of an active state than an explanation of it. Taking the same path, in this study I am concentrating on real instances of state support for renewable energy in Finland to collect empirical data that can serve as a basis for elaborating the "entrepreneurial state" concept further in the Finnish context.

Atkinson and Silverman (1997) suggested that we may be living in an "interview society" where interviews are a central social technique to make sense of ourselves and the world. During the past several decades interviews have become a common way of obtaining information and constructing meaning, not just in everyday life and media but also in social sciences and research (Gubrium & Holstein 2001). The ubiquity of interviews as a data collection method prompted the development of interviewing as a method of scientific inquiry (Kvale & Brinkmann, 2009).

Qualitative research interviews are based in conversations and attempt to explore the meaning of the subject's experiences and opinions, and uncovering their world prior to scientific explanations (Kvale & Brinkmann 2009:1). The research interview is a professional conversation whereby "knowledge is constructed in the interaction between the interviewer and the interviewee" (Kvale & Brinkmann 2009:2). There is no strictly defined type of knowledge that qualitative interviews usually produce, yet it can be said that such interviews are made to derive interpretations, rather than facts or laws (Warren 2001:83) as well as experiences, desires and opinions (Kvale & Brinkmann 2009:36).

One of the objectives of my research is to explore the private sector's experiences of getting state support for developing renewable energy innovations. Interviewing is thus a good methodological choice as interviews can help me understand the good and the bad aspects of such experiences from the point of view of individuals directly involved in the

process, while collecting opinions and constructing knowledge on how state support can be improved together with the subjects. Interviews in this study are also a good way of getting first-hand information from the companies that is not necessarily available from other sources of data (e.g. company websites, reports or media) and reveal, in particular, the private and public sectors' outlook for the future.

The epistemology of qualitative interviewing is more constructionist than positivist (Warren 2001:83) and interview participants are regarded as meaning makers. In this study I plan to collect both factual data and opinions drawing on both positivist and constructivist philosophies which makes it possible to place this research in the realist epistemological tradition.

3.3 Data collection

I used qualitative interviews as the main data collection method and the primary source of data. There are different forms a qualitative interview can take, therefore it is often called unstructured or nonstandardized (Kvale & Brinkmann 2009:16). As there are certain subjects I aim to explore through my research (such as innovation development and innovation policies), the most suitable type of interview is semi-structured interview, that can also be referred to as "thematic interview". Kvale & Brinkmann (2009:3) define a semi-structured interview as "an interview with the purpose of obtaining descriptions of the life world of the interviewee in order to interpret the meaning of the described phenomena". Semi-structured character of interviews will allow me to discuss the topics most relevant to the research yet also leave space for the interviewees to talk about their concerns and other possible emergent themes.

Many researchers acknowledge the importance of preparation in interview studies (Kvale & Brinkmann, 2009). To ensure smooth conduct of interviews and structure of the whole study, I have prepared an interview guide with suggested themes and questions for the interviews. The main themes include experience with state support, innovation development inside the interviewee's company, renewable energy market in Finland, frustrations and problems of the interviewee's company in developing renewable energy innovations. The guide can be found in Appendix 1. In practice, neither an interview nor a

respondent is ever the same, so the guide served only as a suggested outline of themes and each time I have adjusted the questions according to the interview flow.

As part of preparation for the interview I also carried out desk research to collect the information on the company or organisation interviewees represented – this was based on a variety of secondary data sources, e.g. company websites and publications, media articles and press releases. This preparation allowed a better understanding of the working context of the respondents and eliminated unnecessary factual questions in the interview, leaving more time for discussing opinions and guiding the construction of knowledge. Before conducting the interviews, I briefed all interviewees on the objectives of my study and informed them on the general topics of the interviews.

Apart from interviewing representatives of the private sector, I have also conducted additional interviews with individuals and organisations with relevant knowledge in the field that I could reach. Those interviews supported my understanding of the context of the Finnish innovation system and renewable energy market. The list of all conducted interviews can be found in Appendix 2. I will now explain more specifically what the two interview sets were, what I intended to find out from each and what kind of sampling methods I used.

Interviews with the private sector

This is the key set of interviews for the study. The the purpose of these interviews was to understand how state support experiences may have influenced the development of renewable energy innovation in companies. Through these I wanted to find out how businesses interacted with the Finnish government, what innovation support is crucial in their sector (i.e. their type of renewable energy), what worked and what did not work for them when they received state support.

I have used theoretical sampling, i.e. selection of respondents most relevant to the analytical criteria of the research (Warren 2001:87) to identify companies and company representatives to be interviewed. An ideal interviewee in this set was a representative of a company involved in the development of a technological renewable energy innovation with the knowledge of and experience with state support schemes, e.g. applying for or receiving state grants. My goal was to interview from three to five companies (one key representative from each) to ideally cover the main types of renewable energy (wind, solar,

biofuel and geothermal) as their development has been taking different directions and the policy and economic context for each is quite different (see next chapter).

I also aimed at interviewing companies of different size so that could be related to the types of government support for which company or project size is often a decisive factor. As I do not aim to cover all cases of state support for renewable energy that happened to date, several interviews from key sectors describing the most prominent innovations should be sufficient to tap into the main research subjects and reveal key problems and needs for state support on which I can base my recommendations for policymakers.

Supporting interviews

With the supporting interviews, I aimed to collect opinions that are relevant for the research and may offer interesting perspectives on looking at the state support from the point of view of organisations directly involved in policymaking, research or innovation and business development in the field of renewable energy. For instance, I aimed at interviewing a representative from academia who could help me understand how Mazzucato's research has been discussed in Finland. One key target organisation to interview in this set was SITRA (see p.47) who plays a leading role in setting future agendas for Finland and has been involved in the development of the cleantech sector. In general, I have used my supervisor's recommendations and personal connections to identify the interviewees in this set. Since the interviewees represented different kinds of activities and organisations, these interviews were rather open than semi-structured, and the questions were based on the same interview guide but focused a slightly more extent on Mazzucato's research.

A total of eight interviews were conducted (see Appendix 2). In all interview cases I have gained access to the interviewees through emails or phone calls. The interviews mostly took place at the interviewee organisations' premises. All interviews were conducted in English and took from 30 minutes to one hour. All but one interview were recorded and transcribed word-to-word to serve as the material for data analysis.

Besides the interviews, I have also conducted desk research based on secondary sources to build a context for innovation policies and renewable energy market which serves as an introduction to the findings. The sources included websites, articles, books, reports, documents, media texts and the like. This was also helpful in filling in the gaps in the

interview data as each interviewee's knowledge of, for instance, renewable energy support tools, was quite limited by their own company perspective and experience.

3.4 Data analysis

The data analysis was conducted using qualitative data collected through the interviews (7 transcripts and notes from one of the interviews). That data was supported by secondary data but only the transcripts were coded.

I have first coded the data using different coding techniques to analyse the interviews, e.g. magnitude coding (for opinions), structural coding (data on main research subject), descriptive coding (summaries of interviews), verbatim coding (for interesting citations and metaphors) and evaluation coding (for evaluation of state support or interaction with the state) (Saldaña 2009). I went through several coding cycles and identified the main themes based on themes I intended to discuss (see Appendix 1) and themes that emerged in the interview. I then separated the findings containing facts and critiques from findings containing normative data on how the state activities could be improved to present them separately. Within both parts I have synthesised the findings from different interviews so the final structure of the findings is based on themes. During the process I have also searched separately for data on the companies in the interviews and included it in company profiles where I combined it with data from secondary sources. All coding was done manually.

The second stage of analysing the data was based on the principles of thematic analysis. Though considered by many practitioners just as a type of coding, Braun and Clarke (2006:6) suggest that it is a method of its own that can be defined as "a method for identifying, analysing and reporting patterns (themes) within data". A "theme" in this case "captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set" (Braun & Clarke 2006:10).

By using a realist method such as thematic analysis, I can identify main themes emerging in the interviews, compare them with the literature supporting the research (e.g. the "entrepreneurial state" by Mazzucato) and thereby find different interpretations of the research topics, i.e. innovation policies and state support for renewable energy. Thematic analysis due to its independence from theory and epistemology (Braun & Clarke 2006:4-5)

is a good tool for data analysis in this study also because the research is qualitative and is not supported by grand theories. The themes in the interview were compared to Mazzucato's research but no strict framework was applied to analyse the data.

The knowledge produced in the study is very empirical and I do not intend to build any theories, e.g. by using grounded theory method for analysis, which was one of the key research methods for many concepts described in the literature review. My expectation was that with the thematic analysis I can identify several themes possibly based on problems or challenges the private sector faces when developing renewables and relate those themes to literature as well as connect them to the final outcome – the recommendations for policymakers. The themes will serve as a basic structure for the discussion of findings in Chapters 5 and 6 below.

3.5 Research limitations and ethical considerations

As already mentioned, I have limited my study to several cases of renewable energy innovation as I do not have a goal to analyse all support tools for renewable energy, nor explore the situation in all companies engaged in developing renewables in Finland. Another limitation for the study is that I focus on the current situation in the renewables development and support in the near future (maybe a couple of years) as well as the latest history of the innovations developed in the interviewees' companies so the study does not imply a holistic analysis of support tools that have taken place earlier in time. The interviews might also have been limited by the language barrier between myself and the interviewees. Due to my lack of knowledge of Finnish, I carried out most of the data collection (including secondary data) in English although plenty of material could have been found in Finnish.

Kvale and Brinkmann (2009:76) suggest that among the main ethical concerns of an interview study are obtaining informed consent, retaining participants' and information confidentiality and understanding the researcher's role. I have followed these practices and informed all interviewees of the purpose of the interviews in advance. All interviews were conducted and recorded only upon the respondents' permissions and the respondents were allowed to withdraw from the study at any time. The confidentiality of participants and their organisations is guarded and taken into account in the discussion part. As the

interviews have produced sensitive opinions and in some occasions strong criticism, it was my task as a researcher to make sure nobody's identities are disclosed so the research is not perceived as a negative criticism towards the public sector in Finland. Otherwise, all companies and organisations have agreed to disclose their names and spoke quite openly about their stories of innovation development.

My role in this research project was to be an independent, detached researcher and observer, limiting my participation to only guiding the interviewees in constructing meaning during the interviews and steering the discussion. This helped me produce more objective findings as I did not aim to influence the thinking of the respondents. Being quite an outsider to both renewable energy companies and Finnish public sector work also helped me be objective in matching the literature and the data obtained through the interviews.

4 RENEWABLE ENERGY IN FINLAND

The purpose of this chapter is to give an overview of the current situation on the renewable energy market in Finland and describe briefly its policies and support tools for renewable energy technologies. The chapter will also shortly discuss a brief overview of innovation policymaking in Finland to build a context in which the findings will be discussed.

Finland is a very energy-intensive economy – much due to its climate, sparsely distributed population and industries consuming a lot of energy. Likewise on the global scale, in Finland, too, the energy sector is causing the most of the greenhouse gas emissions – in recent years more than 70% (Statistics Finland 2016, Findicator 2017a). As the country is committed to combatting climate change, for which increasing the share of renewable energy in Finland is very important.

The share of renewable energy in total energy consumption in Finland has been growing steadily during the past decades and reached 38.7% in 2016 (Eurostat, 2016). Currently the renewable energy types represented on the Finnish market are hydro power, wind power, wood-based types (e.g. black liquor, wood fuels), heat pumps and biofuels (see Figure 1 below).

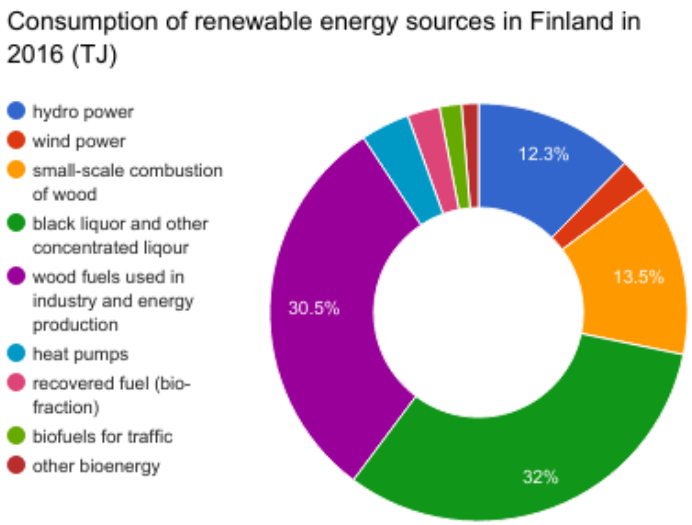

Figure 1. Consumption of renewable energy sources in Finland in 2016 (based on Findicator 2017b)

As can be seen from the chart, the biggest share of renewable energy belongs to wood or biomass-based sources – to a large extent they are by-products of the forest industry. Historically, Finland has developed an expansive and energy-intensive wood industry and, as a consequence, a lot of expertise in biomass-related renewables (Ympäristöinisteriö 2009:39, Motiva 2017). The other sources of renewable energy have so far developed in a much less of a capacity. In 2016 wood fuels amounted to 26% of total energy consumption whereas hydropower to 4%, peat to 4%, wind power to only 1%, and other fuels to 4% respectively (Statistics Finland, 2017).

4.1 Renewable energy policies in Finland

Energy and more specifically renewable energy has been receiving a lot of attention from Finnish policymakers during the past several decades. One of the country's aims is to transition to a carbon-neutral society, therefore Finland focuses on improving energy efficiency and sustainably increasing the share of renewables in its energy mix (Finnish Government, 2017). As expressed in the national vision for sustainable development by 2050[7], part of the carbon-neutral society agenda will be to "develop intelligent and interconnected structures, such as transport and energy systems, that enable and promote the use of renewable energy sources and energy savings, encourage households to improve their own energy consumption and invest in the development of innovative energy technologies and new businesses". Increasing the share of renewables in the energy mix is also part of Finland's plan to implement the United Nations' 2030 Agenda on Sustainable Development[8] (IISD 2017).

Like energy policies, renewable energy policies are contained in the national energy and climate strategy, a policy package developed by the Ministry of Economic Affairs and Employment (TEM). The strategy corresponds to the European Union's climate & energy policy package that is a set of legislation with binding targets in the areas of emissions trading, greenhouse gas emissions reduction, renewable energy, innovation and financing, energy efficiency and security (EC 2017a). Finland's first energy and climate strategy was completed in 2005 in accordance with the aforementioned EU package (TEM 2005) yet at

[7] "The Finland we want by 2050 - Society's Commitment to Sustainable Development". Document adopted at the meeting of the Commission on Sustainable Development, 20 April 2016.

[8] Agenda 2030 for Sustainable Development is an action plan for the global community based on the Sustainable Development Goals adopted by the UN General Assembly in October 2015. Source: <http://sustainabledevelopment.un.org/post2015/transformingourworld>

that point the strategy was concerned mainly with the implementation of the UNFCCC Kyoto Protocol[9] and many renewable energy targets remained undefined.

In 2009 the EU climate and energy package defined binding national targets for the share of renewable energy in final energy consumption for all member states under the EU renewable energy directive: in 2020 the share of renewable energy in the Finnish energy mix is expected to be 38%[10] (EU 2009). In 2014 the European Commission developed the package into climate and energy framework with new, more ambitious targets for 2030 (EC 2017b). In 2016 Finnish energy and climate strategy has thus been updated with new targets, and more concrete measures and goals. According to the strategy, the share of renewables will rise to over 50% during the 2020s (TEM 2016). During the current term (2015-ongoing) the Finnish Government with its project "Towards carbon-free, clean and renewable energy cost-efficiently" has committed to increase the use of renewables according to the EU 2030 guidelines as well as in heating to replace the use of oil with clean renewables (Finnish Government 2017:24).

Finnish policy on biofuels deserves special attention as it is often given credit for creating the biofuel market (Invest in Finland 2017, see also Neste's case below on p.51). There is a national law based on a strict target – fuel distributors have to mix a certain proportion of renewable fuel into conventional fossil-based fuel[11]: the 2016 target for biofuel content was 10% and by 2020 the share should increase to 20% (European Biofuels Technology Platform 2016). According to the 2016 update of the national climate and energy policy (TEM 2016), the target for the share of renewables in transport by 2030 is 30%, however the current government has called for a more ambitious 40% by the same time (Yle 2016). To support the increase of the biofuel usage on the national level, the state has developed subsidies for commercialising biofuel technologies, investments in bio-refineries as well as taxation to ensure fair competition of forest by-products that are the main source for renewable fuel production (ibid.).

[9] International agreement on the reduction of greenhouse gas emissions adopted in 1997 to which Finland is a participating party; the second commitment of the Protocol runs until 2020. Source: <http://unfccc.int/kyoto_protocol/items/2830.php>

[10] As of 2017, this target has already been surpassed by 0.7% in 2016. Source: <http://ec.europa.eu/eurostat/documents/2995521/7155577/8-10022016-AP-EN.pdf/38bf822f-8adf-4e54-b9c6-87b342ead339>

[11] Act on the promotion of biofuels in transport (446/2007). (Laki biopolttoaineiden käytön edistämisestä liikenteessä)

Overall, it can be said that the regulations in the field of renewable energy in Finland are quite developed. World Bank (2016:205) in its scorecard report for policymakers gives Finland a score of 83 out of 100 for its renewable energy policies. The composition of the score is as follows (see Table 2 below):

Index	**Score/Total**
Renewable energy score (total):	83/100
Legal framework for renewable energy:	88/100
Planning for renewable energy expansion:	75/100
Attributes of financial and regulatory incentives:	39/100
Network connection and pricing:	100/100
Counterparty risk:	100/100
Carbon pricing and monitoring mechanism:	83/100

Table 2. Renewable energy scorecard for Finland (based on World Bank 2016:205)

As can be seen from this scorecard, Finland performs quite well in all aspects but attributes of financial and regulatory incentives. Based on World Bank's indicator, this means there is still policymaking work to be done in terms of defining the mechanisms of entering the market for renewable energy producers (ibid. p.150).

4.2 Support tools

Finnish energy policies are complemented with several tools that promote their implementation. There are currently three main support tools for renewable energy, I have summarised them in the Table 3 below:

Title	**Feed-in-tariff** (Decree 1396/2010[12])	**"Energy Aid" Subsidy** (Decree 1063/2012[13])	**Investment Aid for Renewable Energy and New Energy Technologies ("Energy Aid II")** (Decree 145/2016[14])
Explanation	Variable premium tariff on top of the wholesale price for 12 years	State grant for investments in RE production and related research	Investment aid for renewable and new energy technologies
Recipients	Producers of electricity from	For companies,	Companies, municipalities

[12] Act on Production Subsidy for Electricity Produced from Renewable Energy Sources (1396/2010) English translation available from Energy Authority website: <https://www.energiavirasto.fi/documents/10179/0/Act_1396_2010+EN+6.5.2014.pdf/eadd751f-b0b3-4063-8eb5-ab69a42b2a6d>

[13] Valtioneuvoston asetus energiatuen myöntämisen yleisistä ehdoista (1063/2012). Available from Finlex: <http://www.finlex.fi/fi/laki/alkup/2012/20121063>

[14] Valtioneuvoston asetus uusiutuvan energian ja uuden energiateknologian investointituen myöntämisen yleisistä ehdoista (145/2016). Available from Finlex: <http://www.finlex.fi/fi/laki/smur/2016/20160145>

	RE, i.e. new energy plants	municipalities and other communities for projects promoting use of RE, energy efficiency and reducing environmental impacts	and other entities
Eligible technologies	Onshore and offshore wind, biogas, wood chips or wood fuels	All (wind, solar, geothermal, biogas, hydro-power, biomass)	All (solar, wind, geothermal, biogas, hydro-power, biomass)
Conditions	Plant located in Finland/Finnish waters and connected to grid; project meeting economic and technical requirements for electricity generation. More specific conditions also apply to each technology type	At least 25% of project's funding must come from non-governmental funds	Investment aid can be up to 40% of the project's cost
Responsible authorities	TEM, Energiavirasto (The Energy Authority)	TEM, ELY-keskus (Centre for Economic Development, Transport and the Environment)	TEM
Specifics	Premium tariffs only available until the installed capacity reaches a certain maximum	The amount of subsidy is decided on a case-by-case basis	Investment can be up to 40% of project costs

Table 3. Summary of the main RE support tools in Finland

In general, all types of renewable energy are supported with these tools. All the tools are managed primarily by the TEM, financed from state funds and imply allocation through application-based process.

The feed-in tariff was put in place to reach certain capacity targets of wind power, biogas and wood-based power more quickly. The tariff offers a higher electricity price and is given to new plants in Finland producing energy from aforementioned sources. However, it has already been decided recently in the government that the feed-in tariff for wind power will be discontinued due to high cost for the government, so the wind energy producers in Finland will compete on market terms in the future (Reuters 2015; TEM 2016).

During the past several years the main tool for supporting renewable energy enterprises was the so-called "Energy Aid", state money given to companies, municipalities or communities to promoting the use of renewable energy as well as carrying out related research. The main aim of Energy Aid subsidies is "to launch investments [in renewable energy] by increasing their profitability and minimising the financial risks associated with

the introduction of new technology" (TEMa). A more specific subsidy support –"Energy Aid II" – was put in place in 2016 to support investments on renewable energy and new energy technologies (ibid.). A total of 100 m € was allocated by the current government for investment into renewables for 2016-2018 (TEMc).

But do these schemes support innovation in renewables in Finland? The recent report of the Ministry of the Environment on the implementation of the sustainable development agenda in Finland reads:

> "To become carbon-neutral and resource-wise by 2030, *Finland must take determined and ambitious actions* to increase energy, resource and material efficiency, to sustainably grow the share of renewable energy sources, *to produce and export* climate-friendly products, services and *innovations*, and build low emission sectors and business models. *Companies and the innovations they develop will play a crucial role in the achievement of these goals*"
>
> (Ympäristöministeriö 2009:21, my italics)

> "*The transition to a carbon neutral economy*, in other words replacing fossil or nonrenewable raw materials with renewable, sustainably produced materials, *requires the reform of the economy and business sector and the creation of a supportive research and innovation policy*. The transition requires *new production methods, business concepts and ways of organising work*. (...) *Companies and their own innovations will play a crucial role in this*."
>
> (ibid. p.27, my italics)

The importance of innovation for achieving renewable energy targets is clearly recognised and it also seems that the state's actions are really determined and governed by a thorough set of policies with clear targets up until 2030. It is worth pointing out that the government seems to understand very well that research and innovation policies must go hand in hand with the renewable energy policies and that the private sector is key to achieving the targets. However, as also implied by Mazzucato, there is always a higher degree of ambition a government can opt for. In fact, if compared to support tools in other countries, not all kinds of common tools for renewables are available in Finland (see Table 4 below).

Regulatory support	
Renewable energy law:	no
Targets:	yes
Quotas:	no
Economic support:	
Feed-in tariff/premium:	yes
Capital grants and subsidies:	yes
Soft loans:	no

Tax relief:	no
Net metering:	no
Tradable green certificates:	no
Carbon pricing:	no
Auction schemes:	no

Table 4. Overview of the Finnish renewable energy policies (based on IEA 2014:67)

This is not to say that Finland should have all tools in place, as country context offers specific conditions for various policy instruments, but rather to suggest that there are many tools for renewables support developed by policymakers in other states that can also be utilised in Finland.

4.3 Innovation policymaking in Finland

In this part I briefly outline the roles of key public sector organisations involved in innovation development in Finland – the TEM, Tekes and SITRA. The latter was interviewed for this study, so I have included the findings in its description.

Innovation policies, like energy issues, are also overseen by the TEM. The ministry's main tool to encourage innovation is the provision of R&D support, promoting innovation-friendly legislation and developing networks and platforms for the cooperation of different actors (TEMb). The innovation system of Finland is coordinated by the Research and Innovation Council chaired by the Prime Minister (ibid.).

Tekes

Tekes[15] (Finnish Funding Agency for Innovation) is a publicly funded expert organisation for financing R&D in Finland (Tekes-b). It is managed by the TEM and is the government's main agency for innovation funding and technological development (Tekes-a).

Tekes provides small and large Finnish businesses with low-interest loans or grants (EC 2017e). It also provides consulting and internationalisation services, funding for research institutions and universities. The agency has been supporting certain themes and projects to allocate its funding, among them several focused on renewable energy, for instance Tekes

[15] Official website: http://www.tekes.fi/en/

Groove[16] (ended in 2014), the Neo carbon energy project[17] (ongoing) and Smart & Green Growth[18] (ongoing).

SITRA

SITRA[19] is a very interesting case of an independent innovation agency that takes many roles in supporting and promoting innovation; the agency is also mentioned in Mazzucato's "entrepreneurial state" book (Mazzucato 2015c:204). In fact, Mazzucato has been on SITRA's advisory board and provided insights for the organisation's work (SITRA 2017a,b).

SITRA (Finnish Innovation Fund) is an independent public fund founded in the 1960s as part of the Bank of Finland. It was originally set up as an agency for funding innovations, however the organisation's role has changed over the last decades. After Tekes was set up, SITRA decided to focus on societal change and societal development projects to develop new competences and ideas for the Finnish society (SITRA 2017a).

SITRA defines itself as a research-driven think-tank with a future orientation (SITRA 2017b). Its role is to act as a future-focused visionary that challenges ideas and structures in the private and public sector. SITRA's goal is to develop ideas that could become part of the state policy or business activities in the future based on megatrends that shape the world and the economy. SITRA makes effort in developing smart policy ideas and getting the message and knowledge across to the private sector, politicians and the policymakers from different industries. (SITRA 2017a.)

The organisation is officially not part of the state apparatus, however it is supervised by the advisory board consisting of members of the Finnish Parliament. The advisory board nevertheless does not influence the choice of strategic themes in SITRA's work. (Ibid.)

SITRA conducts studies based on societal trends to define opportunities and quantify them for the business. The agency also takes into account the Finnish context, including the political momentum, market establishment and Finnish expertise, as well as an outlook for global potential and competitive advantage for Finland. The organisation tries to influence

[16] Tekes Groove Programme: http://www.tekes.fi/ohjelmat-ja-palvelut/recently-ended-programmes/groove/
[17] Neo carbon energy project: http://www.neocarbonenergy.fi/
[18] Tekes Smart & Green Growth: http://www.tekes.fi/en/programmes-and-services/tekes-programmes/smartgreen-growth--clean-transition-to-the-bioeconomy/
[19] Official website: http://www.sitra.fi/en/

big business players and help them redefine their strategy (SITRA 2017b). SITRA also noted that a typical modality of their work is bringing different stakeholders from public and private sector as well as academia on board to work on experimenting and piloting new ideas (SITRA 2017a.)

SITRA takes credit for developing the venture capital and private equity in Finland in 1980-1990s and setting conditions for the emergence of private funds. In the past SITRA had directly invested into early-stage companies from its own endowment fund to finance R&D, including some RE cases. However when Tekes was given a mandate to manage R&D funding for small companies, SITRA ceased its investment operations and is now acting as fund-of-fund by investing in venture capital funds that do cleantech investments. (SITRA 2017a).

Work on the topic of energy and RE has been a large part of SITRA's activities since 1970s. Since the beginning of the 2000s the agency has conducted multiple projects on climate and energy and continued to carry the outcomes of its studies to the Finnish policymakers and politicians. One of their projects initiated the discussion on small scale wind and solar-power solutions in Finland. Currently SITRA is focusing on the role of consumers in energy transition. It has also been actively exploring the German experience of Energiewende[20] policies and how it could be applied to the Finnish context. (SITRA 2017a,b)

[20] Energiewende denotes Germany's politically supervised shift to renewable energy. Source: http://www.dw.com/en/what-exactly-is-germanys-energiewende/a-16540762

5 FINDINGS AND DISCUSSION

This chapter is the first of two chapters discussing the findings of the study. I first begin with presenting the overview of the interviewee organisations to describe what kind of RE or innovation-related work they are involved in and how that is relevant to the study. The second part of the chapter contains the discussion of findings structured by themes. These themes were produced as the outcome of thematic analysis and include both intended themes (as based on the interview guide) and themes that emerged during the interviews.

I start with bigger themes moving to the themes that were less discussed. The findings in this chapter are mainly based on facts and critique, as well as stories of the interviewees' experience but not their opinions on how the RE support can be improved (that is discussed separately the next chapter). The discussion below is based on both interviews with the private sector and supporting interviews as all offered interesting perspectives on the Finnish energy and RE market as well as the challenges of state policies and support tools. Where relevant, I also supplement the themes with comments based on Mazzucato's "entrepreneurial state" work or its critique.

5.1 Overview of conducted interviews

A total of eight interviews were conducted for the study (see Appendix 2) – three with businesses and five supporting interviews with representatives of relevant companies and organisations. Although I originally aimed at conducting more interviews, some respondents were hard to reach, however 50 pages of data were collected and it was enough to generate many interesting topics, opinions and suggestions.

The companies in the business interviews set formed a good sample as their activities covered all main types of renewable energy – solar, wind, bioenergy and geothermal. However, they were all quite big so the findings may be limited to their perspective of interacting with state policies or aid for renewables, in contrast to, for instance, the same experience small companies might have.

The interviews produced some stories of innovation development inside the companies and there was quite a lot said about Finnish energy policies, state support, energy and RE market in general. One of my hypotheses was that the private sector has a very clear idea

of what kind of government support is needed for their innovation-related operations (e.g. R&D, commercialisation), however they rarely expressed it clearly in the interviews; I was surprised that it was the organisations from the supporting interviews set that had much more to say on how they think government should work in terms of RE development support.

Interviews with companies

The companies interviewed in this set were ABB Oy, Neste Oyj and St1 Oy. One representative from each was interviewed; their competences included product and sales management of RE products, RE product development and executive R&D management. Below I have laid out company profiles and their stories of getting state support based on the interviews.

ABB

ABB[21] is a Swedish-Swiss multinational corporation operating in the field of industrial technologies. It has been in business for over 125 years and developed into a leading provider of power, energy and digitalisation utilities. The company got involved in RE several decades ago when they started developing hardware for hydro power plants. Currently in Finland ABB produces heavy generators for different type of applications, components and converters for wind turbines.

Recently the company opened a solar power plant on the rooftop of one of its buildings in Helsinki (ABB). The plant is by far the largest grid-connected solar plant in the Nordics and is a test facility for the company's solar inverters (designed and manufactured also in Helsinki) in cold weather conditions. The project was partly financed by the TEM from its renewable energy system investment fund (ibid.). The company's facility in Helsinki is globally responsible for testing solar inverter technologies and developing them for ABB's international markets (ibid.). ABB Finland is also involved in the Deep Heat geothermal energy project (see p.52) in Espoo, Finland, for which they provide the motor and the drive.

The company has used state support before for building up goods for export. The ABB (2017) representative commented that even though the company is large, they use state support for the research that they cannot turn into profit and participating in state

[21] Official website of ABB Finland: http://www.abb.fi/

programmes can bring some income. Otherwise, ABB comments, they would have to use their own human resources for free, so getting a small amount of funding is fair to cover the costs of research. (ABB 2017.)

Neste

Neste[22] is an international oil refining company based in Finland. It started as a fossil fuel company but in the 1990s saw a need to focus on greener solutions even though climate change issue was not that apparent at the time (NESTE 2017). The company had developed ideas for renewable fuel but put them on hold as there was not yet any market for that (ibid.).

Currently Neste's vision is to create responsible choices for fuel and to decarbonise society. The company has developed its renewable fuel business from scratch since 2007, which they consider a big achievement. Neste's 100% renewable fuel is used by aviation fleet, passenger cars, and public and marine transport. The product was very new to the market and took several years to break-even in 2013 (ibid.). In 2014 Neste's renewable diesel was named the most groundbreaking Finnish business innovation of the new millennium by Finnish newspaper Talouselämä (2014). Currently Neste is the leading global producer of renewable diesel and half of its profits in 2016 came from that product (Invest In Finland 2017, Neste 2017).

Neste sees developing renewable fuel as their way to innovate as an oil company. They also see it as a growth opportunity and the main driver for their business (Neste 2017). The company still produces fossil products, as well as products that are a combination of fossil-based and renewables-based fuels. As company representatives noted, 80% of their renewable diesel is based on waste, so there is still space to innovate to make that percentage bigger. (Ibid.)

Two thirds of Neste's R&D expenditures go into renewables. Annually the company spends around 40m € on R&D, of which 65% is invested in feedstock development, i.e. finding new sources for renewable fuels. The company representative adds that Neste has been successful due to building a great feedstock supply chain and investing a lot into the R&D for new products. Neste has also participated in public research projects with Finnish universities where they usually fund 65% and Tekes funds 35% of costs. (Ibid.)

[22] Official website: http://www.neste.com/fi/fi

Neste has been participating in research projects with Finnish universities and businesses but some projects have not materialised yet since there is not yet a market for them to be commercially viable. The company has been continuously receiving between 1m-4m € R&D funding support per year from Tekes. Neste's own yearly R&D investment is around 40m €, so Tekes funding amounts up to ten percent. The company commented that recently Tekes funding has been cut due to their shift of focus to SMEs. Neste added that it has undergone a couple of unsuccessful attempts to receive funding from the TEM and is generally on the lookout for Finnish and European funding. (Ibid.)

St1

St1[23] is a Finnish oil company that also operates in the Nordic market. The company's mission is to promote renewables and to be the leading producer of carbon dioxide-aware energy (St1 2017b). Although the company still sells conventional oil, it invests its oil profits into renewables R&D. St1's key "*world class innovation*" to date is ethanol produced from waste that is used as fuel for flexifuel cars (St1 2017a). The company also owns half of the Finnish industrial wind power company TuuliWatti Oy. St1 is also involved in local energy solutions and building heat pump plants for local houses. (St1 2017a).

Currently St1 is the leading company behind the Deep Heat[24], a pilot geothermal energy project in Espoo, Finland which the company is building with the help of their partner network. The goal of the project is to build the first industrial heat plant running on geothermal energy in Finland (St1 2017b). If the project is successful, the technology may be scaled in the Nordic countries (ibid.).

St1 does a lot of R&D to develop its renewable fuels and has previously used R&D grants from Tekes. The company is always on the lookout for new opportunities around energy production – RE, energy efficiency, demand side management and others (St1 2017a). The representative of St1 mentioned that the company owner holding the most shares is very ideological and risk-taking so he often makes decisions to invest in very risky projects like Deep Heat (ibid.).

[23] Official website: http://www.st1.eu/
[24] Project website: http://www.st1.fi/deepheat

Supporting interviews

In this set, a total of five interviews were conducted – with Erkki Ormala from Aalto University School of Business, Joukon Voima, Finnish Energy (Energiateollisuus) and two with SITRA (see p.47). Erkki Ormala is Professor of Practice in Innovation Management who has been involved in innovation-related research in Finland for many years and provided expert opinions on the Finnish innovation system for this study.

Energiateollisuus[25] is a Finnish organisation for the industrial and labour market policy of the energy sector. It represents most of the Finnish electricity market with 250 members, including most of the Finnish RE producers. The organisation's main task is to lobby for its members' products and policies that it sees as good for them and Finland in general. Energiateollisuus is concerned about climate change and supports Finland's decarbonisation agenda, however it disagrees on certain policy measures taken by the Finnish policymakers. (Energiateollisuus 2017.)

Joukon Voima[26] is a Finnish startup providing a crowdfunding platform for sustainability projects, including RE. In 2013 the founders realised there was a need for ordinary people in Finland to be able to support RE transition through investing in such projects. Currently the company is still developing and is undergoing multiple applications for state support, e.g. from Tekes. (Joukon Voima 2017).

5.2 Discussion of findings by themes

The following text is a discussion of findings structured by themes – I first discuss themes that received more comments from the interviewees and continue with topics that were discussed less.

Finnish energy and renewable energy market

The interviewees often pointed out that the development of renewable energy, like energy in general, is very capital-intensive and risky. It is hard to grow a profitable and successful business in that kind of environment, so businesses are very dependent on subsidies in this area. The energy sector has always been appealing in terms of technological innovation –

[25] Official website: http://energia.fi/
[26] Official website: http://joukonvoima.fi/

for instance, Finland produced CHP (combined heat and power) solutions and has made interesting developments in energy efficiency and nuclear energy (Ormala 2017). However, the sector is undergoing a structural transformation which needs bigger investment, but the overall environment is unattractive due to low prices on the Nordic electricity markets, so it is mostly projects benefiting from feed-in tariffs (see p.43) that get initiated (SITRA 2017a).

My original hypothesis was that the operational environment for markets to develop RE businesses is different depending on the RE type and the findings have confirmed that. The context is different both in terms of technological development and market conditions. Joukon Voima (2017) pointed out that solar energy in Finland is growing in percentages but the growth in volumes is still not significant, yet it could have been faster. Of course, Finland does not get that much sunlight in general, but SITRA, for instance, thinks that the future i.e. of solar energy is still there (SITRA 2017b). It might be, then, that the problems in solar RE development lie in non-environmental reasons. In ABB's opinion (ABB 2017), there is not much space to innovate in solar energy systems and the real opportunity for competitive advantage and profitability may probably be found only in designing racks for solar panels. ABB (ibid.) further commented that it is difficult to get into business with new solar products – the competition is high and finding a margin and a focus point requires real business acumen. The company also expressed its critique of the Finnish taxes for small solar PV[27] systems based on the size of a solar production facility. The amount of generated electricity sold to the grid depends on how much was actually produced (in KWh) rather than the total volume of the system (in KW), since the amount of sunlight is not constant and cannot be predicted. ABB suggests that such taxes really prevent businesses from setting up small solar solutions in Finland. (Ibid.)

As seen from many sources, bioenergy is the most popular type of RE in Finland, however, as SITRA (SITRA 2017b) commented, it is still dependent on subsidies and state support in general. SITRA also reminded that it is understandable that bioenergy developed into the biggest RE type due to the availability of forest resources and expertise of the forest sector in Finland but it is known that in the long run it is not so sustainable and therefore worse for the environment, than, for instance, solar. Geothermal energy is a possibility and an opportunity with a lot of potential, especially because Finland has a solid bedrock so it

[27] "PV" stands for "photovoltaic", meaning a solar energy produced by the means of photovoltaic effect

is easier to drill but ABB reminds that it is a very energy-intensive way to get heat so it will not solve the problem of energy transition either (ABB 2017).

The rule of few

One concrete problem that SITRA (SITRA 2017a) sees as important is the absence of players on the energy market. There are only few (less than five) energy companies that are big enough to afford big investments in products that would bring positive cash flows beyond 2020, and other players (for instance, local utilities or wind parks) do not have resources to scale up their operations nor invest in something new. SITRA comments that such a situation is not healthy for creating a bustling ecosystem needed for investments in RE. (Ibid.)

The problem is not limited to just the fact that there are only few big players. It is also about their resistance to change, as several interviewees pointed out. SITRA thinks that the Finnish energy market has been established in a way that does not support the application of RE or new energy technologies; in fact, the establishment pushes against the transformation and that is also true on the global scale. Big companies "*established their roles and their own boxes on the market and are not happy to have them changed, they are not the best to change their own culture and ways of working*", adds SITRA (SITRA 2017a). The organisation says it is one of the reasons why it is hard to convince investors to give money to the big energy transformation projects (ibid.).

St1 agrees that the number of electricity producers has been limited but adds that nowadays there are more producers (St1 2017a). The company adds that well-established "old players" are against transformative change because their business is going down. They invested in fossil fuels and probably biomass but now the time has come for RE like wind, solar and other. The company comments that "old players" are not happy about the feed-in tariff condition for wind power, which they blame for decreasing the electricity price because they can sell their conventional energy with the market price only. However, the St1 representative pointed out that those big companies could have looked into renewables and explored the opportunities but they have not (ibid.). This proves that in terms of the energy transition, the private sector also needs to lead, it needs to have visionaries. If only the government is active and "entrepreneurial", that is not enough; this is a perspective on the private sector that Mazzucato does not really discuss within the "entrepreneurial state" work.

If one of the problems of the market relates to company size, it is interesting to question whether it matters for innovation development. In one of her working papers Mazzucato mentions that "for renewable energy, scale matters, and larger firms can more easily supply enormous energy grids spanning the continents" (Mazzucato 2015d:27). St1 agreed and said that in large companies it is easier to do the R&D (St1 2017a). However, the representative of Energiateollisuus thinks that neither the rule of few big players nor the matter of size are a problem (Energiateollisuus 2017). He points out that Finland is already a forerunner in the renewable energy on the EU level and that it is relatively easy to install RE capacities on both centralized and decentralized level. A question, however, is whether small size RE projects are economically feasible. As already mentioned, the main reason why small RE solutions do not kick off is the low electricity price, but in principle the operational environment for big and small solutions is the same with only minor exemptions – the same legislation, taxes, policy instruments and permits. In Energiateollisuus's opinion, in many cases policies favour smaller companies. What could be another problem, the organisation adds, is the oversupply situation on the Nordic energy market with more production than demand and that is difficult for all actors regardless their size. (Ibid.)

Critique of renewable energy policies and support instruments

The interviews revealed multiple problems related to Finnish energy policymaking. One of the interviewees had a feeling that the government is not doing much about energy policies and "is mostly dreaming about it"; they further commented that "*Finland is acting like a boy scout when it comes to the EU [energy] regulations*" and that it is not wise to do because other countries, in their opinion, are not doing it. Commenting on the EU's 2030 climate and energy policy update, SITRA said that the targets may be ambitious in terms of Finland delivering on the increase of RE share but it is not even half of what is needed to combat climate change (SITRA 2017a). This can suggest that there is still a lot of space for ambition for the Finnish government to enhance their energy policies but at the same time, it should not be blindly following the EU regulations.

Ormala (2017) thinks that the biggest problem at the moment is funding cuts. He suggests that it was not right to cut innovation funding given by Tekes instead of R&D funding because it is the former that brings growth (ibid.). However, one of the respondents was

quite satisfied with the support system and described it as "*a very good system with a Finnish twist of bureaucracy*".

ABB stated that although the government did put up programmes to build an environment for distributed generation of electricity, the commercialisation of such solutions did not pick up as they were typically small and did not succeed in mass production (ABB 2017). This may suggest that the scale of solutions matters, but also that it is the commercialisation stage of innovation – not just the R&D stage – that also matters, and in this case the state was not able to support that stage of commercialisation. This is in line with the critique of Mazzucato that it is the private sector that deals with putting inventions on the market and if it succeeds, that success has perhaps only little to do with state support for R&D.

The representative of St1 commented that there is nothing negative about state support. In their opinion, energy subsidies are a very good framework for promoting small projects. However, he added, as per the wind power, it might not be the right way as politicians decide the amount of those subsidies on a yearly basis, which is not long-term and too short of a time span for investors to decide on wind power investments. (St1 2017a).

Coming back to the issue of large companies controlling the market, SITRA said that it can be seen in the national energy and climate strategy that they lobbied against large energy transformation and ambitious targets (SITRA 2017a). Only a few, SITRA added, were loud and clear in expressing that a faster transformation is needed as well as rethinking of the current strategies (ibid.). It can be concluded that the alignment on the Finnish energy market seems a very sector and country-specific issue that adds a challenge for the development of RE in the country.

Mazzucato, in the beginning of her "entrepreneurial state" book, alludes to the common perception of government as bureaucratic and slow, and as interviews show, the Finnish state can be described in that way too. "*We would ask for [public funding] help now and we would probably get it in three years*" Joukon Voima lamented (2017). The company explains that the public sector's working pace is much slower than that of a startup company that "*needs to do the dough today and get the bread out of the oven tomorrow*" so it is problematic and not worth the effort. When the company was set up, it was quite open for collaboration with the public sector but they called it off as they realised that such collaboration would not be fast moving. (Ibid.)

Joukon Voima described the process of getting funding from Tekes as very heavy and bureaucratic. The company referred to the application process for getting funding as a "*forever going machine*" where Tekes is constantly requiring more information. Although Joukon Voima admits that the public sector has to be careful with their spending, they further commented that Tekes's "innovation voucher"[28] (5000€ funding for startups) has a very strict requirement for the development stage of applicant companies, which is not wise since that kind of very small aid would not make a difference to developed startups but it is a meaningful amount for very early stage small companies. (Joukon Voima 2017.) St1 also raised an issue of overly strict requirements for state aid – sometimes the company wanted to carry out small R&D projects in Finland but when applying for public funding, bumped across the requirement for such projects to be bigger, to aim for growth and internationalisation as well as have a partner network of different actors (St1 2017a).

The findings show that there are many opinions on the energy policies in Finland, both positive and negative. They also show that such factors as company size and type of renewable energy can create a different environment for the interaction of private and public sector. The Finnish state is still a bureaucratic machine with complex and slow application and procurement processes that, in worst cases, prevent businesses from getting public aid and even discontinue certain R&D projects.

Subsidies for wind power

Among the support tools for RE in Finland the interviewees were most critical of the wind subsidies, i.e. the feed-in tariff for wind power. One of the interviewees thinks that Finland has been very slow in establishing support systems for RE in general, especially for wind and solar power. In their opinion, "*the wind support failed as bad as it can ever fail with wind subsidies*" and the desired outcome of the subsidy was not achieved. Such an outcome, in their mind, should have included further industry growth and employment. Joukon Voima (2017) commented that after the wind subsidies have been cut, the industry is "*frozen*" and then there is political uncertainty that makes it difficult for wind power business to develop further.

However, the perceived failure of the wind subsidies may have happened also on the private sector side. ABB (2017) commented that several years ago Finnish businesses were interested in small-scale wind power generation for which they got incentive from the

[28] Tekes innovation voucher: http://www.tekes.fi/en/funding/SME/innovation-voucher/

government, however the business did not continue successfully. The interviewee explained they should have focused on applying existing technologies rather than designing new power generators so it was not the right investment decision on the private sector's part. This illustrates that to succeed in innovation it is also important that the private sector is skilled in using state money wisely, which could be an important addition to Mazzucato's work.

Energiateollisuus and St1's views on wind subsidies were quite neutral. In St1's opinion, the feed-in-tariff, even though it has been costly for the state and quite high compared to the market price, has achieved its goal and fulfilled Finland's target for wind power without the use of additional instruments (St1 2017a). The same has been said by Energiateollisuus, however the organisation adds that there are things to learn from the feed-in tariff policy. Namely, the policymakers' biggest mistake was not reflecting market development (competition, changing cost structures) and technological development which happen on a faster pace than the long-term stretch of the feed-in tariff (Energiateollisuus 2017).

Politicisation of the energy sector

One of the most discussed issues emerging in the majority of interviews with companies was the politicisation of the energy sector in Finland that has been apparent, especially during the last ten years (Energiateollisuus 2017).

One issue inside a bigger problem of politicisation is political cycles that run quite fast. The four-year term with fixed two-year periods and yearly periods for defining state budget means uncertainty for the private sector as incentives might be cut off due to, for instance, conflicting political interests within parliament regarding certain RE technologies, which is another big problem revealed in the interviews (ABB 2017, Neste 2017, SITRA 2017a,b). Political short-terminism is a problem for investors who need stability to make long-term decisions to invest in RE projects (Neste 2017).

ABB gave the example of the Central Party (Suomen Keskusta) that during the time in power largely supported energy from wood pellets. The organisation laments that many residential building owners invested into pellets, however later the party became disinterested in pellet technology and the market had shrunk (ABB 2017). ABB further commented that the decision of the Finnish Parliament to shut down coal plants was

completely political, perhaps implying that it could have been different if the market players had their say (ibid.).

The representative of Energiateollisuus was of the same opinion as ABB that policymakers have an increasing willingness to focus on certain energy technologies based on their knowledge without taking into account the demands of a larger energy system and the energy market in Finland (Energiateollisuus 2017). In ABB's opinion, Finnish political parties are not experts in energy issues which is a lost opportunity as they could focus on enabling the Finnish energy market and an environment for developing energy products and services for export (ABB 2017).

Neste adds, however, that there are different motivations for the state to focus on certain technologies (NESTE 2017). For instance, the current government has spoken quite strongly for bioeconomy as – apart from reducing the impact on the environment – it can also create jobs and increase GDP. The biofuel regulations are driven by the state's willingness to become more independent from imported oil but also the obligation to have the targets set by wider EU regulations (ibid.). In ABB's opinion (ABB 2017), politicians lack perspective on how to use Finnish natural resources with minimum harm for the environment. For instance, biofuel is not sustainable in the long run so it is not wise to support it so much. However, the development of the biofuel industry has been quite successful and plays into the hands of politicians (ibid.).

Finnish innovation system

Several interviews have been generally quite positive regarding the Finnish innovation system. Ormala pointed out that since the 1980s until the 2008 crisis, Finland was one of the most successful countries in terms of innovation policies and R&D spending. Much of the development happened after joining the EU and establishing Tekes (Ormala 2017). The good elements of the system include collaboration between different parties (SITRA 2017b), good levels of Finnish scientific and engineering expertise (SITRA 2017a), and cooperation between industries and universities so that the research supports real business projects (Neste 2017).

In Ormala's opinion, after late 2000s the state has been taking measures that began destroying the innovation environment (Ormala 2017). The public and private sectors are becoming more and more detached from each other (ibid.) and overall, Finland is not

anymore that successful in innovation as the "Nokia-effect"[29] is over (Neste 2017). However, as SITRA (SITRA 2017b) pointed out, recently there has been a lot of startup development yet it is not clear whether the state knows how to respond to that.

In the "entrepreneurial state" Mazzucato (2015c:45-46) writes that a state can fulfill its leading role in the innovation system by mobilizing resources and networks of diverse stakeholders. In Ormala's opinion, currently nobody is fulfilling that role in the Finnish innovation system, so it is missing a system integrator or orchestrator , which is a very critical function of such a system (Ormala 2017). He added that this role was naturally assumed by Nokia in the past as the big company engaged with different groups of stakeholders for various R&D projects (ibid.). SITRA's representative agreed and said that if a driver of the system has to be pointed out, it is the TEM as it is in charge of innovation policies and larger guidelines (SITRA 2017a), however the situation can be described this way: "*[The TEM] is more of a driver of a horses and a carriage. So you have the carriage behind and that is what you are trying to take forward. Then you have six horses [other state organisations, e.g. Tekes, VTT] of which some you control, some not really and one of them does not really have the bells and everything on, so...probably it could be run better*". Contrary to Ormala though, it can be argued that the integrating role in the system is partially fulfilled by SITRA as they manage and lead stakeholder networks for their innovation and pilot projects (SITRA 2017a,b).

Insufficient venture capital

The supporting interviews often raised the issue of the shortage of venture capital in Finland. SITRA pointed out (SITRA 2017b) that there is finance missing for a certain development stage of young companies but the organisation was not able to identify the exact gap. The volume of capital is not enough and private investors are missing which is, in the interviewees' words, perhaps the biggest problem of developing RE innovations in Finland (SITRA 2017a,b; Ormala 2017). However, Ormala commented that in Finland under 1m € funding for startups is usually available but it is hard to get big funding from either the government, i.e. the TEM or private investors. As per big state funding, the reason for that might be that Finland is a small country and does not have enough resources

[29] The "Nokia-effect" refers to Nokia's considerable contribution to the growth of the Finnish economy during the company's successful years. Source: <http://www.economist.com/node/21560867>

to invest in big risky projects (Energiateollisuus 2017), or, as put by Neste, "*we cannot afford to do things just for fun*" (Neste 2017).

As already mentioned above, the problem is not just in the absence of capital but the unattractiveness of the energy market for investment due to low energy prices (Energiateollisuus 2017). Small companies seem to suffer most from this as it is difficult to draw the line between R&D funding, demonstration subsidies and funding for early stage companies (ibid.).

The interviewees with businesses did not raise the venture capital issue. St1 explicitly said that the absence of funding is not a problem for the company; they prefer to own their projects (i.e. not offer equity to investors) and have enough company funds to invest internally (St1 2017a). Neste's R&D expenditures are 90% financed by themselves (Neste 2017) and does not see the shortage of funding as a problem either. However, both are big companies with established resource base and most likely it is the small early stage companies that do not get enough venture capital funding in Finland.

Regulations create markets

One of Mazzucato's key ideas of an "entrepreneurial state" is that it is a state that actively creates and shapes the markets. St1 and Neste both stated that in case of biofuels, it was the Finnish legislation (the requirement to blend in a certain portion of biofuels into fossil-based fuels) that created the market.

St1 (2017a) told that as soon as the requirement was put in place, the company had to find a way to get ethanol, preferably for a cheaper price. They started an intensive R&D process and that led to innovative ways of producing ethanol from waste (ibid.). Neste revived its research projects on renewables and was also successful in developing their renewable diesel technology quite fast. It put an aggressive 1.5 bn € investment into production plants and in a few years the product succeeded on the market (Neste 2017). The company commented, that the biofuel market would not have developed without the legislation since it is more expensive to produce renewable fuels and at that time they would have been difficult to sell as sustainability was not valued that much (ibid.).

However, the biofuel market has systemic implications, regarding the availability and use of vehicles suitable for certain fuels, e.g. flexicars for ethanol, St1 added (2017a). The company laments that this, too, is related to politics as politicians also give preference to

electric cars instead of flexifuel cars, the time for which has not yet come in Finland (ibid.).

It can be concluded that the biofuel regulations did indeed create the biofuel market in Finland and quite successfully so; however, it is more likely that the state's main goal was to fulfill the EU targets rather than create the market, so the market development and shaping role was played by the private sector and their own investment into R&D.

Finland is Finland: national context matters

One of the main critiques of Mazzucato's work is related to its limit to the US context only. Although she acknowledged that national and sectoral context for innovation is important (Mazzucato 2015a:14), she mainly commented that in smaller states it may be more difficult to lead a decentralized network of innovation organisations. The interviews show that the problem with small countries like Finland is also the small size of sectors, e.g. energy sector and the alignment of players (see p.55) which creates certain conditions for the innovation environment.

It is however very difficult to compare the US to Finland in this sense. As SITRA puts it, the US "*lives to trade*" and Finland "*trades to live*" and that is a fundamentally different perspective on the economy and perhaps also the role of the state in the economy (SITRA 2017a). The interviewee further added, that it was possible to send a man to the Moon with 3% of the US GDP, but the same portion of the Finnish GDP would not be able to finance an endeavour of the same scale. As put nicely by SITRA, "*it is a very awkward question of scales that gives us [in Finland] an excuse to try our best but kind of on our own terms*" (SITRA 2017a). However, the scale perspective does not limit the Finnish state from being an "entrepreneurial" leader and risk taker, it is rather the volume of market and innovation capital that may put restrictions on innovation development in the country.

It is also interesting to question whether energy policies and a transition to decarbonised society (e.g. 100% renewables in energy) could be perceived by Finnish policymakers as a mission. SITRA (2017b) thinks that it could, however a mission should be concrete enough (e.g. put a man on the Moon) whereas in the energy transition there are several competing interests and several ways to achieve the goal by using different technologies. It could nevertheless be organised as a big societal goal with not just environmental but business and economic potential (ibid.). But then it also comes down to the question of scales and

spending – if a mission is labeled "*Finland will be the country that solves climate change and energy issues for the whole world*", the discussion would be on the tradeoffs between spending on RE applications to help the world and investing in e.g. elderly care or schooling for kids in Finland (SITRA 2017a). It is unlikely, SITRA maintained, that in the couple of years the Finnish political landscape could shift to the "world first, Finland second" rhetoric, so the case for missions in this context is not strong (ibid.). The organisation recently conducted a survey on Finnish business leaders which has shown that they all agree that something needs to be done on the issue of climate change but it is somebody other than Finland who has to take the lead (e.g. the EU, China, India or the US) (ibid.). It would therefore be hard to imagine the Finnish state setting up innovation missions, including in the renewable energy field, however it does not mean that innovations or success in RE cannot happen without labeling such effort a "mission".

Critique of Mazzucato's "entrepreneurial state"

Some of the interviewees were directly familiar with the "entrepreneurial state" research and expressed some of their criticisms.

One of SITRA's representatives thinks that Mazzucato's work is a good and insightful conversation starter on the role of the state in the economy and which points at an important issue (SITRA 2017a). However they added that it is "*too American*" and "*trying to make a case where it does not exist*", i.e. that it was the state not the private sector, who made some of the most breakthrough innovations possible. Ormala (2017) criticised Mazzucato for not having enough insight on national systems of innovation. Even though she quite explicitly refers to the concept, in his opinion, she omits the fact that an "entrepreneurial state" would only be possible in countries where an innovation system is already very strong and well-functioning.

What SITRA representatives also noted is that in relation to the "entrepreneurial state", it is very difficult to think of Finland in the relation to the risky funding that Mazzucato talks about. The issue would be the small size of the Finnish market and innovation projects, so it would not be realistic to invest in multiple projects and cover the losses with gains from successful project which is exactly the idea of Mazzucato's (SITRA 2017b). Energiateollisuus (2017) added that it is in general quite difficult to imagine the conditions in which the Finnish government could be "entrepreneurial" and get involved in risky funding.

6 RECOMMENDATIONS FOR POLICYMAKERS

In this chapter I continue the discussion of the study's findings, now based on the opinions given by the interviewees on how to improve renewable energy support in Finland as well as other relevant topics that emerged during the interviews. The chapter therefore answers the research question and presents the main outcome of the study – the recommendations for policymakers.

I originally expected to base my recommendations on the interviews with the private sector only, but the supporting interviews have offered interesting comments on the same topics which I decided to also include in the recommendations. The recommendations are structured by themes that correlate with the themes from the previous chapter. In each recommendation theme I try to discuss the issue from general to specific, and concrete ideas from some interviews are also included.

In the second part of this chapter I present a list of the recommendations in the form of a concise bullet point summary. I then summarise the recommendations and discuss the findings from both Chapters 5 and 6 in relation to Mazzucato's "entrepreneurial state" concept.

6.1 Discussion of recommendations by themes

The following part contains the discussion of recommendation by themes. These themes for are laid out in a way so that first I present ideas that emerged only in the business interviews, then ideas that were discussed in both business and supporting interviews, finally moving towards ideas suggested by interviewees in the supporting interviews set.

Strategic long-term governance

All of the business interviewees were quite clear in expressing that the Finnish government needs to have a long-term outlook into renewable energy. Neste (2017) remembered that two to three years ago when the policies beyond 2020 were not made, it was very unclear what would happen beyond that year and therefore they did not feel secure in making any further investments. The company explains that in the biofuel industry, business needs to have more than two years visibility of what is going to happen in the future, and since biofuels are heavily regulated, the policies need to stretch for considerably longer

timeframes (ibid.). Now with the 2030 proposal for the national climate and energy strategy, the environment seems much clearer. Neste also suggests that roadmaps for policy implementation and targets (e.g. for fuel content) should be in place as they give the company a clear outlook on how the market will grow (ibid.).

Joukon Voima (2017) suggested that the worst thing the public sector can do to RE investors is to change its mind on the subsidies over a short period of time, as it happened with wind subsidies. In their opinion, to significantly grow RE in Finland, a stable political environment is needed with predictive long-term strategies, plans and goals, to which the government sticks. In St1's opinion, long-term strategies are also important, however the company thinks that RE subsidies can help quicken development at the moment, yet are not needed in the long-term (St1 2017a).

"Out of the box" thinking and energy system transformation

The interviewee from ABB stated explicitly that what they are looking for from the government side is "out of the box" thinking – "*something different, something unique, something one could use Finnish natural resources for*" (ABB 2017). They also suggested quite a concrete idea: for instance, new Finnish highways could be covered with solar panels structured with Finnish timber. Even though it is not possible to produce that much solar energy in Finland, in this case it would be enough to light up the highway and save the energy which is otherwise wasted since road light usually spreads in all directions. With such a setup with a solar "roof" over highways it is possible to save money on snow clearing. ABB adds that it is an expensive idea however a possible one. (Ibid.)

The ABB representative also commented that key energy sources change over time and that nowadays the time has come for a new energy source which is yet undefined. Geothermal energy is an opportunity, but the government should create a programme focusing on finding new ways of sourcing and managing energy, completely different from the ones already existing today. The company representative comments that it could be related more specifically to frequency, power adjustments and distribution of energy and finding a way to export new solutions to the Nordics. Further, such programmes could focus on combining radically new methods with existing energy systems. (ABB 2017.)

In fact, ABB further commented that government support should not focus only on helping develop technologies for export, but also on trying to transform the whole energy system in

Finland. As power plants are being shut down, the balance between energy load and production is getting worse and alternatives must be found. Not only the natural environment is changing due to climate change, but also the business environment of the energy sector is changing as more flexibility and controllability of energy loads are needed; old energy systems need to be replaced. ABB concludes that the state should focus on the development of energy production from a systemic perspective rather than giving support to small, fragmented projects. (ABB 2017.)

I think that such types of suggested "out of the box" and big systemic thinking could be an opportunity for the Finnish government to pick up technologies or ideas that, as Mazzucato has said, the private sector would not dare pick up because of the risk and induced costs.

Regulations can create markets

In ABB's opinion (2017), there is no need for politicians to always put up support schemes to encourage RE development, as in certain cases regulations can create the markets. However, it is then a question of whether politicians are bold enough to incentivise with regulations as it is not easy to do so. An example could be changing the current Finnish mining regulation, which the ABB representative thinks is one of the worst in the world, since no offset of the environmental harm of mining is agreed upon getting permissions to mine. Mining permissions could be combined with an obligation to build RE power plants on the mining sites so that they could supply mining operations with energy and also feed extra RE energy into the grid, which will also help pay off the mining investments. (Ibid.) As seen on the biofuel example, the Finnish government has indeed succeeded in creating that market with regulations, so the "entrepreneurial state"'s role of creating new markets has been fulfilled and could be further fulfilled in regards to other RE technologies, however, this requires bold actions on the Finnish politicians' side which, as the interviews have shown, the private sector is very skeptical about.

Less requirements for public funding

Some of the business respondents – based on their own experience with public agencies and funding – expressed their opinion on how the application process should be simplified. In Joukon Voima's opinion (2017), it would be optimal if the funding application process was "*straightforward*", "*quick and dirty*". The company notes that for small startups smaller amounts of funding, even micro funding (a couple of thousands of euros) would be

much more meaningful and convenient than big chunks of funding starting from 200 000€ that are much longer and difficult to get from an organisation like Tekes (ibid.).

For Neste it would be convenient if there was not a requirement to get a certain amount of Finnish SMEs and universities on board when doing a research project with public funding. The company explains that the best business partners and universities are sometimes found outside Finland so it would be great to have flexibility on selecting them. Even though Neste understands that the money comes from the taxpayers in Finland and should therefore be invested back into Finnish universities and SMEs, the company maintains that the wealth from that kind of international R&D cooperations would still be created here in Finland. (Neste 2017.)

For St1(2017a) it is important to carry out small research projects so it would help not having the requirement for growth, scaling and internationalisation which many public funding opportunities in Finland often have.

Role of the state in innovation and the economy

Much in line with Mazzucato's thinking, the representative of Energiateollisuus (2017) stated that the Finnish government has already played a big role in the development of RE in the country and that it should continue to be involved actively. The state should also continue funding many RE projects so that state expenditures are transparent, their economic costs can be estimated and in the end the state may evaluate its own policies. However, the organisation's representative said that they are cautious about other active involvement the state might have in the economy which does not mean there cannot be other good roles the state could assume. (Ibid.)

The St1 representative stated explicitly that they do not believe that markets take care of everything. In their opinion, policies and legislation are needed and the government should force companies to do something about climate change. The markets will not change the world for the better, so the state should help with regulations, however not creating too many of those. The focus could be on giving support to demonstrations and pilot projects, as well as R&D because that, in the interviewee's opinion, makes the markets willing to get involved (St1 2017a).

Freeing energy from politics

One of the business interviewees was quite strongly suggesting that everything related to energy should be "*totally cut off from political guidance*" so that the horizon for the market development would be much clearer for all stakeholders. They suggested that there should be a tactical group consisting of the representatives from the private sector, and researchers who can define both short-term and long-term targets for the development of energy markets and systems. That kind of steering by different stakeholders would enable politicians to adjust the regulations so that the energy environment is totally market-driven.

Energiateollisuus suggested that policymakers' main task should be taking care of general investment environment. The organisation said reducing political risks, i.e. risk of politicians and policymakers suddenly changing their mind, is important. An example is the recent proposal to triple real estate taxes for wind power plants, which was unexpected as it contradicts the main message that policymakers have been sending in their support for renewables in Finland. (Energiateollisuus 2017.)

Technological neutrality

It was quite clear from the interviews that it is problematic for the private sector when the government is picking technology winners in its policies. Energiateollisuus (2017), representing the majority of Finnish energy producers, suggests that in general, all kinds of new technologies that can help reduce carbon dioxide emissions should receive support for demonstration projects from the government. St1 also mentioned that the state should not be picky on certain biofuel types as it may limit the company's business since often companies specialise in certain kinds of biofuel (St1 2017a).

In Neste's view, it is very important that the government decides the target (e.g. the percentage of biofuel content, or, more generally, the target for reducing greenhouse gas emissions), however the way to reach the target should be left open, so that the market decides on the best solution. The company maintains that different technologies and solutions are needed to reach many policy targets related to climate change and "*all of them need to happen*". (Neste 2017.)

For instance, Neste is not happy about defined percentages for certain feedstock types applied in biofuels in the latest 2030 climate and energy proposal from the European Commission as it limits the company's feedstock pool quite a lot, and prevents the whole

industry from growing faster. In particular, the company sees that the proposal is trying to open markets for cellulose-based fuels. Neste has already done R&D projects on that type of fuel but put them on hold as such products would not yet be commercially viable. The company says that if the regulations are adopted, the market will be open, however cellulose-based fuels will still be very expensive to produce. (Ibid.)

Neste generally thinks that it is healthier to let the markets decide on winning technologies instead of a situation wherein the state is trying to impose some technology on the private sector. The company maintains that sometimes it is the second best technology that eventually becomes better off and that it is the markets that can find the most cost-efficient way to achieve the impact that is needed. (Ibid.)

In her "entrepreneurial state" book Mazzucato (2015c) often mentions that the states are often blamed for being bad at picking winners; she gave an example of the US state investment in Tesla and Solyndra, of which the former company has succeeded and the latter failed miserably. As per the Finnish government, the interviews suggest that the private sector is quite strongly against the state picking technological winners, however it seems to be related to pure politics, and the politicians' preferences for certain types of technology and politics is almost never mentioned in Mazzucato's work.

Using Finnish expertise

Quite apparent in the interviews was a general suggestion for the policymakers to focus on the resources and expertise found within the national borders of Finland. ABB (2017) suggested that the state should focus on elaborating the correct ways to use Finnish natural resources in RE, e.g. wood or hydropower.

Energiateollisuus (2017) pointed out that Finland has one of the most advanced energy systems globally, so the organisation thinks that huge possibilities for technological development may be found there, so the state should focus on that aspect of the energy sector. Ormala (2017) sees an opportunity in combining Finnish expertise in energy and ICT into smart energy expertise which Finland could be very good at. SITRA (2017a), too, suggests that smart energy (including grid balancing, energy efficiency, industrial management) is something Finland is already good at so more resources need to be invested in developing those competencies so that they can also become goods and services for export and thus bring value to Finland.

Ambitious state

Some of the suggestions of the non-business interviewees were related to the level of ambition in energy policy. SITRA is very strong in advocating general increase in the deployment of RE in Finland (SITRA 2017a). The organisation is in favour of a strong hike in the level of ambition in Finland's national climate and energy strategy and supports stronger and faster targets to increase carbon dioxide emissions (ibid.).

Energiateollisuus is quite sure that bold long-term policies are needed with strong targets. However, the interviewee added that it is difficult to think of what other exact policy instruments could be applied (different from the ones already in place) and that Finland should not copy bold policy strategies like Germany's Energiewende. (Energiateollisuus 2017.)

Funding and investing

The interviews with non-business representatives all pointed at the venture capital problem but it was mostly SITRA representatives that had some ideas for how funding in general could be improved. In relation to Mazzucato's arguments on "patient" finance, one of SITRA's representatives suggested that it would be ideal to have a "patient" long-term private equity investor with a mandate to take on risky assignments or ventures that nobody else dares to get involved in, from which the RE sector would definitely benefit. However, such an argument would be very difficult to sell to Finnish politicians who might be afraid of the headlines like "*this is the crazy fund that uses taxpayers' money to finance solar panels in the sending-to-the-Moon type of initiatives*" (SITRA 2017a).

The other representative of SITRA (SITRA 2017b) suggested that Finland is too small to find a solution for better funding inside the country so there might be a need to create at least Nordic or probably European structures to solve the venture capital problem. Another suggestion is that since many interesting energy and RE ideas could be found in the booming startup environment in Finland, the government needs to take this into account and come up with support initiatives to facilitate the further development of startups (ibid.).

Market-based instruments

Neste mentioned that the private sector cannot be trusted in building markets based on the value of sustainability (Neste 2017). It could be that some of the solutions to the larger sustainability problems need an approach that is familiar to the markets – such indirect policy instruments are often called "market-based instruments" (Climate Policy Info Hub).

Energiateollisuus (2017) thinks that the emissions-trading scheme[30] should be the main policy instrument to promote renewables and reduce carbon dioxide emissions a the EU level. However, it should not overlap with other subsidies for renewables that are already in operation (ibid.). The organisation also suggests that current subsidies (like, for instance, feed-in tariff) should take into consideration market reflection – cost structures, technological development and competition (ibid.). SITRA (2017b) is also in favour of emissions trading and thinks that the TEM could put up a consistent carbon trading scheme and more generally, look into market-based instruments that can help promote renewables and make the energy market as efficient as possible.

Supporting pilot and demonstration projects

SITRA (2017a) suggests that Finland needs more RE references cases and piloting projects like Deep Heat (see p.52). The organisation's recent study shows that the best conditions for pilot development are in the Helsinki regions where different stakeholders can collaborate quickly and experiment with new RE solutions in a "fail fast" manner, demonstrate new technologies, and scale them up (SITRA 2017a).

Energiateollisuus generally thinks that if the state has extra money, it could be invested in the development of new technologies which are not yet commercial. Those could also be technological areas where Finland has leadership and the subsidies could focus on such kinds of technologies rather than helping technologies that are already competitive on the market. (Energiateollisuus 2017).

[30] The European Union's emissions trading system (EU-ETS) is its key market-based climate policy tool. Source: http://ec.europa.eu/clima/policies/ets_en

Focusing on the demand side of the energy market

Mazzucato has been criticised for not taking into account the demand side of the markets and, as seen from suggestions by Energiateollisuus, huge opportunities for energy markets may be exactly on the consumers' side.

Energiateollisuus commented that for a long time energy production industry in Finland has focused on the production side but in the future the value chains will move to the demand side and the profit will be made from services and smart technologies that will create additional value (Energiateollisuus 2017). There are therefore big business and technological opportunities on the demand side where there are smaller actors, and the threshold for coming to business is smaller, and therefore investments are also more likely (ibid.). The organisation also thinks that Finland already has expertise inside and outside of energy companies which can be utilised in the consumer side (ibid.).

However, the question is then whether the government can help develop the demand side. Energiateollisuus hopes that the Finnish business is wise enough to realise that opportunities are on the demand side before the policymakers get involved, as they might not be good at taking into account the change of business and technological landscape in their policies. In other words – markets first, policies second: the organisation maintained that the main driver for the demand side is commerce and what the state could do is, again, support R&D and new technology development. (Ibid.)

6.2 Summary of the recommendations

Based on the findings, the recommendations on improving RE support can be very concisely summarised as follows (see Figure 2 below):

1. Play an active role in RE development

- Play an active role in the development of RE
- Help RE markets with policies and regulations but know your limit
- Raise the market's' interest in developing RE by supporting pilot and demonstration projects and R&D
- Continue funding RE projects

2. Be ambitious

- Set bold and more ambitious targets of the national climate and energy strategy
- Aim for faster and stronger deployment of RE

3. Think long-term

- Create predictive long-term policy strategies, goals, plans and implementation roadmaps with clear targets
    - For renewable energy, create long-term (5-10 years) visibility
        - Create further than 2 years visibility on biofuels
- Enable stable political environment by sticking to such strategies
- Assess the need for RE subsidies in long-term

4. Think "out of the box"

- Think "out of the box", unique and different
    - Create a programme focusing on completely new sources of energy to develop new products and services for export
- Focus on combining radically new solutions with existing energy systems

5. Free energy from politics

- Cut off energy issues from political guidance
    - Create a tactical advisory group with representatives of business and research institutions to define short-term and long-term targets
    - Adjust the regulations to make energy environment market-driven
- Reduce political risks: do not make sudden decisions on policies, regulations and instruments that contradict overall strategies

6. Be technology neutral

- Support all kinds of technologies that help reduce carbon dioxide emissions
- Define targets (e.g. biofuel content, carbon dioxide reduction) but leave it open for the market to decide on winning technologies
- Support fair technological competition

7. Focus on market-based instruments for RE

- Use emissions trading as the main policy instrument to promote RE, make it consistent
- Make sure policy instruments do not overlap
- Make subsidies like feed-in tariffs include market reflection (on cost structures, technological development and competition)

8. Create markets with regulations

- Use regulation as an instrument to create certain RE markets

9. Support pilot and demonstration projects

- Create reference cases for new RE technologies
- Encourage and support pilot and demonstration projects
- Focus on providing support to non-commercialised new technologies

10. Make public funding less bureaucratic

- Make application processes for public funding straightforward
- For smaller businesses give funding in smaller amounts
- Be more flexible in the requirements for partners in public research projects
- Do not ask from all projects to have a focus on growth, scaling and internationalisation

11. Act from Finnish context

- Do the best you can with Finnish expertise and resources
    - Come up with effective ways to use Finland's natural resources for RE (e.g. wood, hydropower)
    - Use Finland's advanced energy system and define opportunities there
    - Combine Finnish ICT and energy expertise into smart energy competence
        - Invest in smart energy competences and develop goods and services for export based on it

12. Focus on systemic transformation

- Focus on transforming the whole energy system of Finland
    - Take a systemic, not fragmented, perspective on supporting energy production
    - Replace old energy systems with new systems
    - Look into the balance between load and production

13. Try solving the venture capital problem

- Establish a state fund for giving out "patient" long-term funding to risky RE projects
- Create Nordic or European venture capital structures
- Elaborate ways to support Finland's booming startup scene

14. Remember to support the demand-side too

- Help businesses develop demand-side energy solutions
- Support such solutions with R&D funding
- Let the private sector create markets first and then create support tools, not vice versa

Figure 2. List of recommendations for the policymakers

Most common recommendations call for the state that remains active in providing support for renewable energy, thinks in the long-term and develops strategies to ensure market certainty for investors and the private sector on the whole. The interviewed businesses also suggest that the policymakers do not give preferences to certain RE technologies and choose the winning technologies instead of the private sector. At the same time, the private sector acknowledges that certain markets for new RE technologies can be created by

regulations. It was also suggested by businesses that public funding requirements and application procedures are made less bureaucratic.

Based on the supporting interviews, the government should be more ambitious in setting renewable energy policy targets, focus on market-based policy instruments and try solving the venture capital problem. Energiateollisuus specifically suggested that opportunities should be explored on the demand side of the energy market. Based on the majority of interviews proposed that the policymakers find ways to utilise Finnish national resources and expertise to develop new RE technologies, possibly also as goods for export.

In general, I think that the recommendations generated by the interviewees provide quite realistic advice to the policymakers and offer an interesting perspective along the spectre of the state vs. markets involvement in the economy and innovation. Some of the similar recommendations were expressed by several interviewees, some – more specifically by certain interviewees, so there is space for some inconsistencies.

It might seem at first that, for instance, "governments letting markets decide" and "taking an active role" are recommendations that contradict each other. However I think that in the context of this research they are quite compatible, since the active role of the government referred mainly to the state's activity in offering support tools and the rule of markets – to the suggestion that the state should stay technology neutral in its RE policies. Decoupling energy from politics might be a very tough call since energy is strongly related to security, however I think that it may be possible for the state to make energy issues less political and remain involved on the policymaking (not politics) side.

6.3 Discussion of findings in the context of the "entrepreneurial state"

Below I discuss how the overall findings of the study (from both Chapters 5 and 6) relate to the "entrepreneurial state" concept.

In general, I think many would agree that the Finnish state at this point is already far from a mere "market fixer", taking into account the amount of policies and regulations in many sectors, not just the energy sector. This means that in the analysis of the Finnish state's involvement in economics and innovation one cannot depart from seeing the state as only "fixing markets", which is what Mazzucato does in her "entrepreneurial state".

Based on the findings, it seems that the interviewees already acknowledge an important role the Finnish state has played in enabling an environment for the development of RE innovations in the country. However, I would not dare claim it as strongly as Mazzucato does on the US example that it was the state, not the private sector, that made RE innovations possible in Finland. On the contrary, I would conclude that, based on the stories of the interviewed companies, much credit has to be given to the private sector and its effort in R&D that helped develop RE products and put them on the market.

What I think is especially interesting in respect to Finland and the role of state that Mazzucato envisions, is the existence of SITRA. Although not officially representing the state, based on the interviews, I think that the organisation already assumes some features of an "entrepreneurial state". It plays a visionary role picking strategically important sectors in the Finnish context and it brings actors and stakeholders together for innovative projects, which I think is the manifestation of the orchestrating role the state should play in the innovation system, as suggested by Mazzucato.

In general, I would say that the recommendations call for an active role of the Finnish state in RE innovation, but not the *leading* one, so it is not the same level of ambition as suggested in the "entrepreneurial state". Such kind of state would welcome failures, however most of the interviews were rather skeptical of the Finnish government welcoming failures as they will always be held accountable by the taxpayers.

The findings are well in line with Mazzucato's calls for the state to think big and follow a long-term vision. She suggested that innovation should become the states' growth policy and I think that some of the interviewees' comments on supporting the development of RE products for export can relate to it.

Throughout her research Mazzucato calls for the states actively "creating and shaping markets". Even though some interviewees did agree that, for instance, the biofuel market in Finland was created by regulations and that it is one way to open certain RE markets, I do not think that can be equated to Mazzucato's call.

One can conclude that Mazzucato thinks that the state should not rely on markets, however I think the recommendations in fact call for the opposite, especially in the case of the market naturally selecting the winning RE technologies. However, Neste's comment that the markets cannot be trusted to operate on sustainability values is in line with

Mazzucato's thinking on "green entrepreneurial state" (2015d) that called for an active involvement of state in the cleantech sector. In relation to that, she also mentioned that the government's involvement in green energy should stretch beyond R&D aid since the commercialisation of RE technologies is also important. The findings confirmed that commercialisation is important indeed, but it was not suggested explicitly by any of the interviewees whether and how the state might support the innovations in putting them on the market. In line with Mingardi's critique of Mazzucato, the suggestion from Energiateollisuus was exactly related to the demand side of the energy market, however they did not produce any suggestions on direct state support in this area.

Based on the findings in this study it seems unlikely that, for instance, the mission-oriented policy approach would apply in Finland since it does not seem to fit the Finnish political rhetoric. Generally, it is also unlikely that Finland can exercise risky innovation funding described as one of the key features of the "entrepreneurial state". In fact, the findings show that Finland cannot afford to be risky, does not have a pool of RE projects to take a portfolio approach to investment and has a general shortage of private venture capital; therefore, there cannot be a discussion on state investment, "crowding out" private investments as suggested by Mazzucato.

So is there a need for an "entrepreneurial state" in Finland in relation to the renewable energy context? I think the question is somewhat tricky to answer based on the findings as in Finland the state has already been quite involved in renewables. I think that generally the recommendations paint a picture of a state that is involved but is not leading, which is not the same degree of involvement of the state in innovation that Mazzucato's whole "entrepreneurial state" study has called for. They do not paint a picture of an active risk taker and funder and based on the whole study I do not think that there is a big need to reconsider the role of the state as suggested by Mazzucato, at least in the renewable energy sector.

7 CONCLUSIONS

It was important to research the state support for renewable energy innovations as there is an acute need to transition to renewable energy as part of the decarbonisation imperative that will help fight climate change. More specifically, it was important to understand what the policymakers can still do to enable the environment to enable RE innovations.

I have conducted the study using the main themes found in Mazzucato's "entrepreneurial state" and applied this concept to the renewable energy sector in Finland. This helped unpack the role of the Finnish state in the development of RE innovations to determine how the concept can be applied to specific national and sectoral context, which filled some of the research gaps in the "entrepreneurial state" discussion.

The study questioned the ways in which the state can support the private sector in the development of renewable energy innovations in Finland. It has answered the research question with multiple themes and reached its main objective: based on the findings, a set of recommendations to guide policymakers in the development of RE support was developed.

As I hypothesised in the beginning, the study has proven that it was worth examining the "entrepreneurial state" under the Finnish context to show how different the Finnish national environment for innovation is from the US context, on which the original "entrepreneurial state" research was based. Applying the concept to the energy sector has also yielded many important sector-specific implications that can enrich the discussion on both the "entrepreneurial state" and energy transition.

7.1 Research summary

The predominant themes discussed in the research interviews related to critique of the Finnish RE policies and support tools, politicisation of the energy issues, the Finnish energy market environment and insufficient venture capital for innovations. Overall, the research revealed a lot of challenges and concerns of both the businesses involved in RE innovation development and other organisations related the energy market and innovation policies in Finland. Two biggest themes which unexpectedly emerged from the interviews naturally were the politicisation of the energy sector and the specific conditions of the Finnish energy market (i.e. low electricity price, few big players with reluctance to

change). In relation to Mazzucato's discussion on the role of the state in innovation, the findings present a view of the Finnish state that has already been actively supporting RE innovations.

The research findings acted as a basis for developing a set of recommendations based on fourteen themes. The main recommendations call for the government to: play an active role in RE development; be bold and ambitious, think "out of the box"; depoliticise energy issues; be technologically neutral in policies; support new technologies, pilot and demonstration projects and use the Finnish expertise and market context to develop innovations. Overall, the recommendations call for an active and involved state, but not an "entrepreneurial" one in the conception of Mazzucato.

The research findings are in line with Mazzucato's call for long-term policies and an active role of the state, however it also confirms the critique of the "entrepreneurial state" that, beyond R&D, it is also the effort of the private sector which is extremely important in making RE innovations successful on the market. The study did not generate any sufficient discussion or knowledge on the risk and reward relationship in state investment or the leading role of the state in national systems of innovations, which are also characteristics of the "entrepreneurial state".

The study's novelty is contained in the application of the "entrepreneurial state" to the Finnish cleantech context and one of its most important conclusions is that the "entrepreneurial state" discussion depends a lot on scale, i.e. country size or market size. Moreover, the study has shown that the energy sector is quite specific due to its ties with politics and the existence of old and rigid energy systems and players with reluctance to change. Other new knowledge generated in the study connects the energy market with politics, which is not mentioned in Mazzucato's "entrepreneurial state" and in my opinion offers a very challenging perspective to the concept if it is applied to the cleantech sector. However, this study does not answer whether the concept of the "entrepreneurial state" can inform policy in a useful way as it still needs to be developed.

The study has also provided some insight into the importance of RE vision and leadership in the private sector, not just the state – to cut it short, both can be blamed for failures and praised for success and even though the state vs. private sector debate continues, it is important to note that it is not a zero-sum game.

7.2 Limitations of the study

The main strength of the study is the amount of themes in the overall topic of RE innovation support it has generated. The research has also managed to take into account the views of both the private sector and non-business organisations which play an important role in the energy and innovation systems of Finland.

The study has only covered three company cases of RE innovations; however even though that is quite a small sample, the interviews still generated a lot of data and covered the main types of renewables: solar, wind, biofuel and geothermal as originally intended. The outcomes of the interviews with the private sector is also limited to the company size as all interviewees represented big established companies for which the need in R&D support is not as big as for small enterprises.

7.3 Practical implications

Put into a larger societal and economic context, the study shows that, as Mazzucato suggested, it is indeed important to unpack and understand the role of the state in supporting innovations in particular sectors. This helps identify sector-specific challenges and therefore elaborate sector-specific policies and policy instruments.

Another implication of the study is that in practice, the discussion of the roles, perceptions and realities of the state and the private sector may take different forms in different national political and economic contexts. It is thus important to understand how the "entrepreneurial state" rhetoric, if need be, can be transformed into a policy instrument to fit the Northern European innovation and larger economic contexts.

7.4 Suggestions for further research

In general, the concept of the "entrepreneurial state" would benefit from further application to various sectors and national contexts. Based on this study, the same kind of research may be conducted with the small companies or startups engaged in the development of renewables with a bigger focus on different kind of state funding.

It would also make sense to better understand how the state can support the export of RE technologies from Finland, as it it quite clear that export is important for the private sector and Finnish expertise in energy already provides good condition for development.

One could further research the possibilities contained in the demand side of the energy sector and perhaps the ways it can be directly supported by the state. In relation to Mazzucato's "entrepreneurial state", in my opinion it would be beneficial to further investigate the discussion on the risk and reward relationship in state investments from the point of view of policymakers.

Finally, since the "entrepreneurial state" touches upon the perception of the state in modern pro-market economies, a discourse analysis study on the perception of the state and its involvement in the economy and innovation in the Nordic countries would be also interesting.

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APPENDICES

Appendix 1. List of suggested interview themes and questions

Engagement with renewable energy innovations

- What kind of RE products/services is your company providing/developing?
- Are you engaged in innovating RE? What innovation-related activities do you engage in?

Interaction with the Finnish government

- Have you been engaged with the state in terms of support activities? With what state organisation and for what purposes? Why did you reach out to that organisation?
  What was the story of that interaction?

State support history

- Have you got any government support in the past?
- What kind of support did you obtain? Was it related specifically to RE or energy development?
- What was the model of allocation of that support to you?
- How did you find out about the state support opportunities available to you?

State support experience

- How would you rate the support received from government overall? What was good about it? What was bad about it? What could have improved it? What worked out and what didn't?
- Did the state support help you achieve internal company goals? Did it help with innovation development?
- What was bad about your state support experience?
- What are the main problems associated with getting state support for your company (and particularly for renewable energy innovation), in your opinion? Does the context of your company matter (e.g. size, type of renewable energy, other)?
- How could the state support experience have been improved in your case?

Needs for state support

- What kind of innovation-related RE activities would you need state support for?
- What kind of state support would be most important for you?
- What would be an ideal state support process for you? What is Finnish innovation system missing?
- What kind of supply-side policies you find more relevant for your case?

"Patient" finance, investing

- What forms of public-private cooperation would you find suitable for your company?
- Would long-term funding with some benefits for the state (patient finance) be acceptable for you?

Strategic support for RE

- In your opinion, is government support important in your field (renewable energy) in Finland? Why do you think you need this support?
- Who should be the state actors responsible?
- Should government be actively and willingly shaping the RE market in Finland?
- What factors in general (if you think about RE innovation development and Finnish innovation system) are important for developing new RE technology in Finland?

- Would you consider engaging in the development of certain RE technologies that private sector is unwilling to deal with (due to market circumstances) if the state would support you with those?

Finnish (renewable) energy market

- What do you think about the renewable energy market in Finland and its directions for/conditions of development?
- What do you think are the difficulties for the development of renewable energy technology and adoption in Finland?
- What barriers in RE innovation development can you identify for your company?

Appendix 2. List of conducted interviews

Interviews with private sector:

14.3.2017	ABB Oy
7.4.2017	Neste Oyj
1.5.2017	St1 Oy

Supporting interviews:

7.3.2017	Joukon Voima Oy
4.4.2017	Professor Erkki Ormala, Aalto University School of Business
12.4.2017, 21.3.2017	SITRA (two representatives)
26.4.217	Energiateollisuus ry